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Precambrian Geology of the Northern Black Sturgeon River and Disraeli Lake Area, Nipigon Embayment, Northwestern Ontario

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ONTARIO GEOLOGICAL SURVEY

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Precambrian Geology of the Northern Black Sturgeon River and Disraeli Lake Area, Nipigon Embayment, Northwestern Ontario

by

T.R. Hart and Z. Magyarosi

2004

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Preliminary Map P.3539 Precambrian Geology of the Disraeli Lake Area, Nipigon Embayment, Northwestern Ontario ..... back pocket

Preliminary Map P.3540 Northern Black Sturgeon River Area Geological Cross-Sections, Nipigon Embayment, Northwestern Ontario ..... back pocket

Miscellaneous Release—Data 133

Northern Black Sturgeon River–Disraeli Lake Area, Nipigon Embayment, Northwestern Ontario: Lithogeochemical, Assay and Compilation Data
by T.R. Hart and Z. Magyarosi

This digital data release consists of lithogeochemical analyses and diamond drill hole information utiiized in the geological interpretation presented on preliminary maps P.3538 and P.3539 as a result of mapping in the northern Black Sturgeon River to Disraeli Lake area of the Nipigon Embayment. The data are being released in conjunction with Open File Report 6138 and Preliminary Map P.3540. Both lithogeochemical and assay samples have associated rock descriptions and locations. Information from the Ontario Drill Hole Database (ODHD), supplemented with drilling information provided by companies currently exploring, or that have conducted past exploration, in this area, had drill hole positions verified and included as Universal Transverse Mercator (UTM) co-ordinates. Magnetic susceptibility measurements for most stations visited during the mapping project are annotated with the rock descriptions and locations. Also included are basic rock type information for the field mapping stations and photographic images labelled with locations, as well as a preliminary version of the thin section database. All positional data are provided in UTM projection and grid system, North American Datum 1983 (NAD83), Zone 16. The data are available as Microsoft® Excel 97 (*.xls*), Microsoft® Word 97 (*.doc*), rich-text format (*.rtf*) or tab-delimited ASCII text (*.txt*) files, a Microsoft® Access (*.mdb*) file and image (*.jpg*) files on one CD-ROM.

This CD-ROM is available separately from the report.

Precambrian Geology of the Northern Black Sturgeon River and Disraeli Lake Area, Nipigon Embayment, Northwestern Ontario

T.R. Hart[1] and Z. Magyarosi
Ontario Geological Survey
Open File Report 6138
2004

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Introduction

Bedrock mapping in the northern Black Sturgeon River and Disraeli Lake area was completed to investigate the regional geological setting of the platinum group element (PGE) bearing mafic to ultramafic intrusion in the Seagull Lake area. The northern Black Sturgeon River and Disraeli Lake map area is located approximately 110 km northeast of Thunder Bay and south of Lake Nipigon (Figure 1). The area mapped during the summer of 2003 has a northeast-trending border extending from approximately latitude 48°59′N, longitude 88°58′W to latitude 49°25′N, longitude 88°30′W. Access is provided by the Black Sturgeon Road, which extends north from highways 11 and 17 at Hurkett, and the numerous logging roads branching to the east and west. The limits of the map area were governed by the interpreted position of the Black Sturgeon fault zone and the location of the ultramafic intrusions at Disraeli and Seagull lakes (Figure 2).

This project was completed by the Ontario Geological Survey as part of its commitment of in-kind support to the Lake Nipigon Region Geoscience Initiative (LNRGI). The LNRGI is a geoscience-based geological data acquisition and compilation program operated by the Ontario Prospectors Association (OPA) and funded through an agreement with the Northern Ontario Heritage Fund Corporation (NOHFC). The LNRGI also includes partnerships with the private sector, Lakehead University and

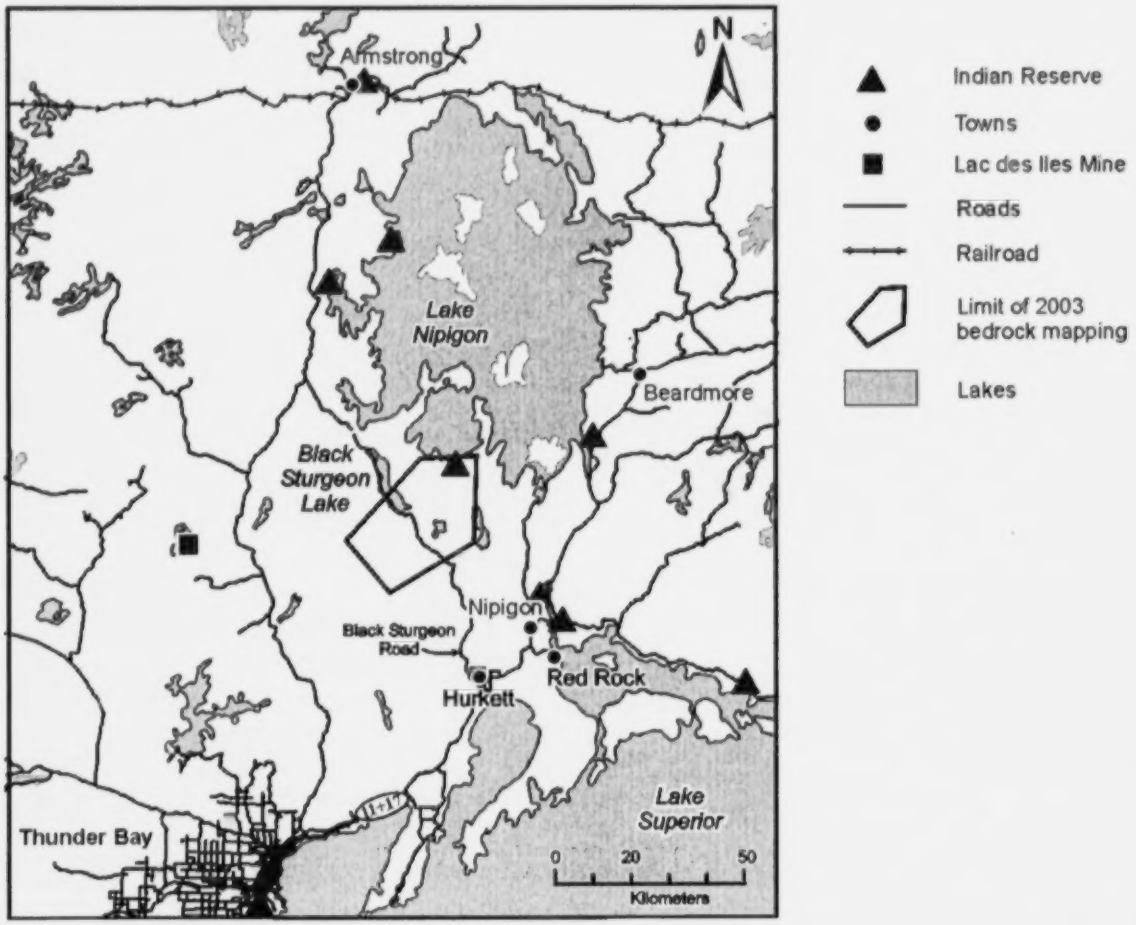

Figure 1. Map showing the location of the study area.

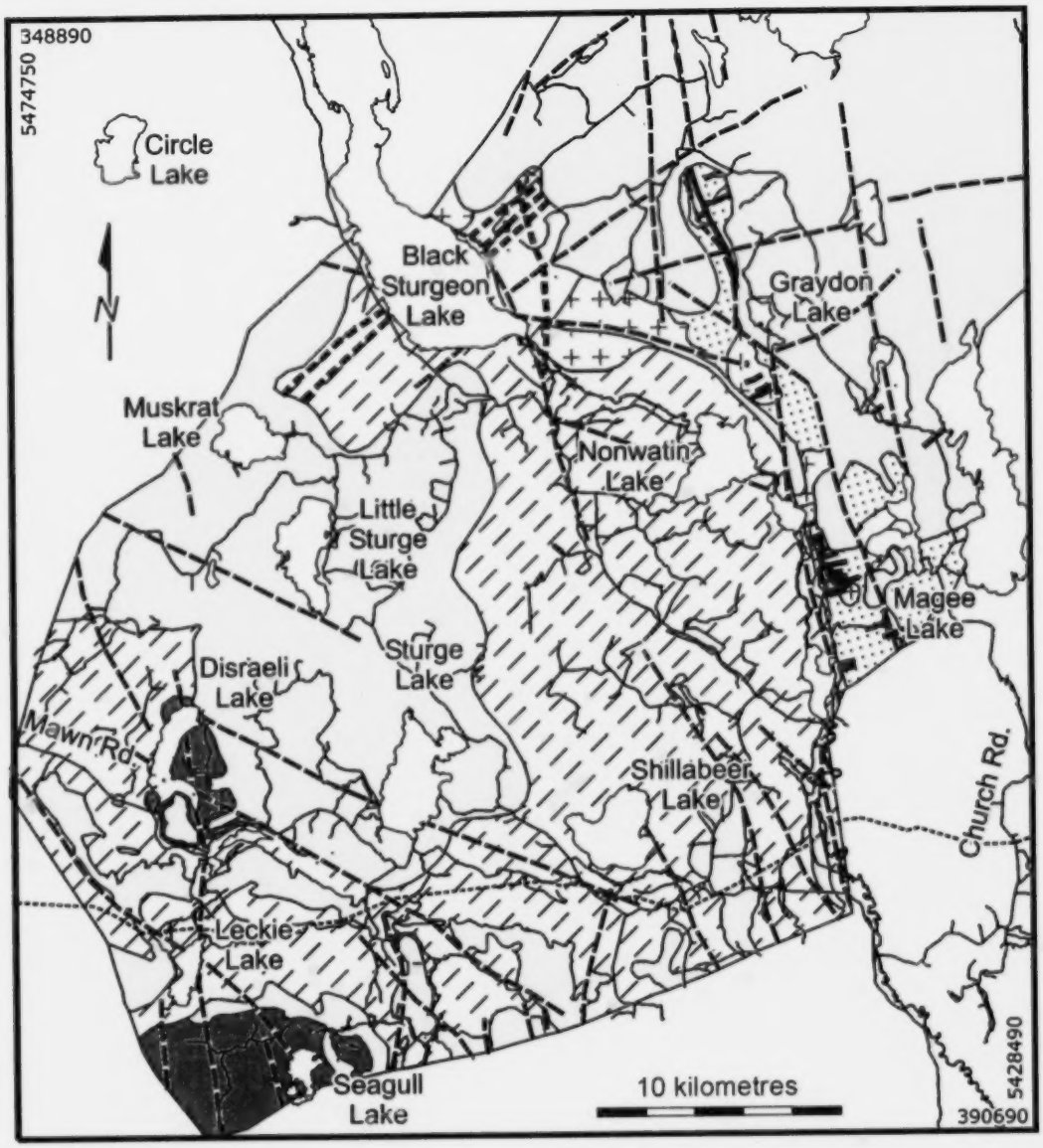

Figure 2. General geology of the Black Sturgeon Lake and Disraeli Lake map area.

communities in the Lake Nipigon area. The major aim of the initiative is to attract interest from international and domestic investors to encourage new mineral exploration investment in high mineral potential areas in the region and adjacent areas; provide a framework for informed future land use decisions; and to contribute to a geological synthesis of the region. The initiative includes bedrock mapping projects, airborne magnetic and radiometric surveys, ground gravity surveys, and targeted surficial geochemical and geochronological studies.

This report includes observations collected during field mapping conducted in 2003 as well as examination of the diamond drill core from a number of exploration holes in the map area and the results of the airborne magnetic and radiometric surveys completed as part of the LNRGI (Ontario Geological Survey 2004). Interpretation of project results was undertaken in co-operation with the Lakehead University partners (P. Fralick, G. Heggie, P. Hollings, R. Metsaranta and A. Richardson). An integral part of this report is the digital data contained in the Miscellaneous Release—Data (MRD) 133, which contains the lithogeochemical and assay analyses.

PREVIOUS GEOLOGICAL WORK

Previous geological mapping by Coates (1972) covered the map area at a scale of 1:63 360, and included an interpreted geological section. The northeast corner of the map area, immediately south of Lake Nipigon extending to the southern edge of Black Sturgeon Lake, was mapped at a scale of 1:50 000 by Sutcliffe (1982). A detailed examination of the intrusive rocks, Nipigon diabase sills and ultramafic intrusions of the Disraeli and Seagull–Leckie lakes areas, was completed by Sutcliffe (1986). A number of regional studies of the Sibley Group sedimentary rocks have encompassed the map area (e.g., Franklin et al. 1980; Cheadle 1986; Rogala 2003).

Mineral exploration and prospecting in the area has been sporadic with the first recorded activity being the exploration for iron ore in the early 1900s (Coates 1972). The discovery of sporadic copper mineralization near Disraeli Lake in 1965 stimulated the exploration for copper and the other base metals in the late 1960s (Coates 1972). Uranium mineralization was first reported in the Black Sturgeon Lake area in 1947, but exploration was not reported until 1975 (Scott 1987). A number of companies were reported to be actively exploring for uranium during the late 1970s (Fenwick et al. 1980). A uranium occurrence was discovered by R.H. Sutcliffe during the 1981 field season and subsequently acquired and explored by Uranerz Exploration and Mining Corporation Limited until 1985 (Scott 1987). Several companies investigated the potential of sedimentary-hosted base metal mineralization in the Sibley Group in the early 1990s, but other than an airborne geophysical survey completed by Cominco in 1993, little of the work was recorded. Exploration for platinum group element (PGE) mineralization intensified after the 1998 discovery of mineralization in the Seagull–Leckie Lake intrusion (Osmani and Rees 1998). The best diamond-drill intersection to date is 1.71 ppm Pt and 1.87 ppm Pd across 2.1 m in basal pyroxenite of the Seagull–Leckie lakes intrusion, which contains 10% disseminated to net-textured pyrite, pyrrhotite and minor chalcopyrite (Durham 2000).

PRESENT GEOLOGICAL SURVEY

The northern Black Sturgeon River–Disraeli Lake area was mapped during the summer of 2003 utilizing road access for the large-scale lithologic unit distribution and detailed stratigraphic sections in areas with the steepest and greatest variation in topography. Geological field data was recorded on a Hewlett–Packard iPAQ™ 3950 handheld computer using a database within the FieldWorker™ software, which was later downloaded to ArcView®. Geographic positions were recorded in Universal Transverse

Table 1. Lithological units for the northern Black Sturgeon River–Disraeli Lake area.

PHANEROZOIC

CENOZOIC

QUATERNARY

RECENT

Lake, stream and swamp deposits

PLEISTOCENE

Glacial deposits, sand, gravel, till

UNCONFORMITY

PRECAMBRIAN

PROTEROZOIC

Mafic Intrusive Rocks (Nipigon Sills)

fine-grained to very coarse-grained diabase; magnetite-rich, coarse-grained diabase, with intergranular magnetite; very coarse-grained amphibole-plagioclase±potassium feldspar[a]; chilled diabase[b]; inclusion-rich chilled diabase[c]; dike; aplite with very fine-grained to aphanitic felsic rock cutting diabase sill

INTRUSIVE CONTACT

Mafic to Ultramafic Intrusive Rocks

peridotite (melagabbro, wehrlite, lherzolite); olivine gabbro[d]; monzogabbro and/or granophyre[e]

INTRUSIVE CONTACT

Sibley Group Sedimentary Rocks

Kama Hill Formation

shale, siltstone, sandstone

Rossport Formation

mudstone; siltstone; dolomite; sandstone; cyclic dolomite–siltstone; carbonate breccia; stromatolitic carbonate; intraformational debris flow

UNCONFORMITY

Diabase Dikes

diabase dikes (metamorphosed and weakly deformed)

INTRUSIVE CONTACT

ARCHEAN

Hornblende Suite

unsubdivided; tonalite to granodiorite

INTRUSIVE CONTACT

Muscovite Granite Suite

muscovite; granodiorite to tonalite; leucocratic granite

INTRUSIVE CONTACT

Biotite Tonalite Suite

leucocratic tonalite; dikes; granodiorite to granite

INTRUSIVE CONTACT

Syntectonic to Posttectonic Mafic Intrusive Rocks

gabbro

INTRUSIVE CONTACT

Clastic Metasedimentary Rocks

feldspathic wacke; argillite; andalusite schist; quartz-biotite-feldspar schist (commonly intruded by leucocratic tonalite dikes; could be classified as migmatite); quartz-plagioclase-biotite±potassium feldspar schist

UNCONFORMITY

Chemical Metasedimentary Rocks

oxide-facies iron formation (magnetite-chert)

Mafic Metavolcanic Rocks

massive flow

Notes

a Amphibole may be either hornblende or actinolite; pink feldspar may be potassium feldspar or hematite-stained plagioclase. This unit could represent a late magmatic phase of the sills, assimilation of Sibley Group sedimentary rocks, or a combination of the two processes.

b Commonly polygonal textured and glassy if the plane of the contact is exposed.

c Biotite-rich matrix containing rounded xenoliths of older Sibley Group sedimentary rocks, Quetico Subprovince metasedimentary rocks, or felsic intrusive rocks.

d Irregular contact with the peridotite only observed in drill core are ambiguous, and geochemistry suggests this unit from the same magma source as the peridotite.

e Forms irregular pods within the olivine gabbro containing a pink feldspar that may be either a late magmatic phase or the result of assimilation of Sibley Group sedimentary rocks.

Mercator (UTM) projection and grid system, Zone 16, North American Datum 1983 (NAD83). These positions were obtained using a Garmin® GPS 76S™ global positioning system with an average of a minimum of 10 readings that usually allowed for a horizontal error of 5 to 7 m and a vertical error of approximately 15 m. In areas with a clear view of the satellites, a real-time differential reading was obtained with an x–y error of less than 1 m, and a vertical error of approximately 3 m. The global positioning system (GPS) positional data was compared with the digital elevation data obtained from the Ministry of Natural Resources, Ontario. The geological data was overlain on a digital base map at 1:20 000 scale derived from the Ontario Land Information Warehouse, Land Information Ontario, Ontario Ministry of Natural Resources.

Exploration information on assay results and diamond drill hole logs were obtained from Earth Resources and Mineral Exploration web Site (ERMES) and the Assessment Files of the Resident Geologist's Office, Thunder Bay. Diamond drill hole locations were initially obtained from the diamond drill hole database in ERMES, with minor corrections applied based on examination of the assessment files.

ACKNOWLEDGMENTS

The author was assisted by senior assistant Sonia Préfontaine, and by junior assistants William Whitty, Roger Fournier and Kimberley Rowledge. Mr. Robert Middleton, East West Resource Corporation, allowed access to diamond drill core from the Disraeli Lake and Seagull–Wolf Mountain properties and provided background information for this map area and the Nipigon Embayment in general. Mr. John Scott, Resource Geologist in the Resident Geologist's Office, Thunder Bay, provided post-processed GPS data for stations as benchmarks that are unavailable in this map area. The staff of the Thunder Bay Resident Geologist office, also provided information on access, camp sites, and background information on the mineral occurrences. Desmond Rainsford for assistance with images of the airborne magnetometer and gamma-ray spectrometer surveys, and a description of the survey parameters.

General Geology

The south Black Sturgeon Lake and Disraeli Lake map area is underlain by Archean rocks of the southern Wabigoon and northern Quetico subprovinces that are unconformably overlain by Proterozoic sedimentary rocks of the Sibley Group (Table 1). Rocks of the Quetico Subprovince and the Sibley Group are intruded by Proterozoic mafic to ultramafic intrusive rocks in the Disraeli and Seagull Lake areas, in the southwest portion of the map area (*see* Figure 2). Mafic sills of the Nipigon Diabase Sill Complex intrude all other rock types in the map area.

A small area of the southern Wabigoon Subprovince occurs in the south-central map area and consists of metamorphosed and deformed volcanic and sedimentary rocks. The metavolcanic rocks are mafic in composition, highly metamorphosed and deformed, and poorly exposed. There are a number of thin, less than 100 m wide bands interlayered with the metasedimentary rocks, and a band that appears to be less than 1 km wide near the south end of Black Sturgeon Lake and the north end of Ferguson Lake (*see* Map P.3538, back pocket). Several small gabbroic textured bodies intruded the metasedimentary rocks, but extent of these units is not known. The metasedimentary rocks are metamorphosed wackes and siltstones with 3 chert-magnetite iron formations. The clastic metasedimentary rocks resemble the metasedimentary rocks of the Quetico Subprovince to the south, and metamorphosed examples of the metasedimentary rocks of the Beardmore–Geraldton Belt. The Wabigoon–Quetico subprovince boundary is interpreted to be located near the southern end of Black Sturgeon Lake, south of the metavolcanic rocks based on regional correlation of the iron formations (e.g., Sutcliffe 1986).

Rocks of the Quetico Subprovince consist of feldspathic wackes and siltstones metamorphosed to upper greenschist to amphibolite grade, with occasional development of andalusite schists. Dikes of the biotite tonalite suite intrude the metasedimentary rocks, usually along the schistosity, and form the leucosome in bands of more mafic composition that could be classified as migmatites. A number of areas contain a high percentage of coarse-grained to pegmatitic dikes and irregular bodies of the muscovite granite suite, and these dikes are also commonly emplaced along the schistosity of the metasedimentary rocks (*see* Figure 2). A number of dikes and a small body of hornblende granite intrude the metasedimentary rocks in the southeast portion of the map area.

A number of north-trending diabase dikes intrude the Archean rocks of the Wabigoon and Quetico subprovinces in the area east of the Black Sturgeon River. These dikes have been weakly deformed and are interpreted to be part of one of the Paleoproterozoic dike swarms.

The Proterozoic Sibley Group sedimentary rocks unconformably overlie the Archean rocks of the Wabigoon and Quetico subprovinces, and have been subdivided into 3 relatively flat-lying formations: the lower Pass Lake, the middle Rossport, and the upper Kama Hill (e.g., Cheadle 1986). Currently, the most reliable isotopic age determination for the Sibley Group is a Rb/Sr age of 1339±33 Ma, which is based on analyses of a combination of Rossport and Kama Hill formation samples by Franklin (1978). The Pass Lake Formation is only observed in drill hole, and consists of conglomerates, quartz arenites and minor dolomites. The Rossport Formation consists of mudstone, dolomite, siltstones of the lower Channel Island Member, limestone and stromatolitic limestone of the Middlebrun Bay Member, and predominantly muddy, variably carbonatized siltstones and mudstones of the upper Fire Hill Member. Units of this formation are the most prominent sedimentary rocks in the central portion of the map area, and appear to form the few areas of Sibley Group exposed to the east of the Black Sturgeon River. The Kama Hill Formation is the uppermost formation of the Sibley Group exposed in the map area and consists of laminated mudstones and siltstones with sandstone prominent in the upper section. This formation is exposed at the higher elevation in the south and west portion of the map area.

Mafic to ultramafic intrusions occur in the Disraeli Lake and the Seagull–Leckie lakes areas (*see* Figure 2), and both are composed of a pyroxene peridotite core with an irregular olivine gabbro zone along the margin. Petrographic examination indicates that the rocks of Disraeli intrusion range in composition from olivine gabbro in the border zone to plagioclase-bearing olivine clinopyroxenite and wehrlite in the core. A study of the Seagull intrusion indicates that it consists of cumulate-textured dunites, lherzolites and olivine websterite, with minor olivine-hornblende pyroxenite with an olivine gabbro border zone. Both intrusions have a monzogabbro phase occurring as irregular pods or bands distinguished from the olivine gabbro by the presence of amphibole and abundant pink feldspar. A diabase sill chilled against the olivine gabbro of the Seagull intrusion is exposed in a number of outcrops northeast of Seagull Lake and both intrusions are cut by diabase sills in drill core.

A series of undulating, generally flat-lying to shallow-dipping Proterozoic diabase sills that commonly form topographic highs as they are more resistant to weathering, and intrude all other rock units in the map area. Davis and Sutcliffe (1985) obtained a U/Pb age of 1109+4/–2 Ma, based on zircon and baddeleyite, from 2 sills on Lake Nipigon. The diabase sills are commonly massive, medium- to coarse-grained feldspar and pyroxene with variable internal subdivisions not exposed in any one stratigraphic section. A generalized section of a sill would contain 1) chill, 2) fine-grained variably amygdaloidal, 3) magnetite rich, 4) medium to coarse grained, 5) coarse to very coarse grained, 6) fine grained, variable amygdaloidal, and 7) chill. The sills range in thickness from less than 5 m to greater than 180 m and there appears to be at least 2 major sills greater than 100 m in thickness. However, erosion and block faulting hinders the correlation of the sills and thus the determination of the original number of sills.

Quaternary sand and gravel deposits form an extensive cover along the west side of the Black Sturgeon River, with an esker located south of Black Sturgeon Lake suggesting that the deposits are in part glaciolacustrine in origin. Quaternary raised beach sand deposits form an extensive cover along Lake Nipigon, with good examples exposed in pits created by road making in the area south of McIntyre Bay. The rest of the map area is covered by differing thickness of till.

The metamorphic grade of the Archean metavolcanic and metasedimentary rocks of the Wabigoon and Quetico subprovinces vary from upper greenschist-facies to lower amphibolite-facies, with limited areas of migmatite present in the Quetico Subprovince metasedimentary rocks. Hornfels metamorphism, in zones up to 10 m wide, is variably developed in the Sibley Group in contact with the peridotites, and occasionally the diabase sills. Hematite and specular hematite is commonly associated with late fracturing in both Archean and Proterozoic rocks, and is also associated with the uranium mineralization on the east side of Black Sturgeon Lake. The hematite appears to be a useful indicator of the north-trending fault systems in this area, where most structures are hidden by talus and glacial deposits.

Metavolcanic and metasedimentary rocks of the Wabigoon and Quetico subprovinces have experienced multiple phases of deformation. Schistosity is well developed along the bedding planes obscuring primary structures and hindering identification of folding events that are probably present (e.g., Beardmore–Geraldton Belt; Hart, terMeer and Jolette 2002). North- and northwest-trending faults form the Black Sturgeon fault zone and have displaced the Proterozoic Sibley Group. Northeast-trending faults are probably zones of minor late movement along previous Archean structures. A series of north-trending faults or fault zone have been interpreted to be *en échelon* resulting in the formation of a block-faulted asymmetric basin or graben. These faults appear to have little lateral displacement based on the correlation of the iron formations across Black Sturgeon Lake. These faults are interpreted to be regionally continuous structures that may correlate with north-trending structures in the northern Gull Bay area. A series of subparallel, northwest-trending faults form part of the fault zone displaying vertical movement with no apparent horizontal displacement, and may be traced to the west into the adjacent Wabigoon Subprovince. Accurate determination of displacements on these structures is not possible as they have been obscured by talus slopes and glacial deposits.

ARCHEAN

Metavolcanic Rocks

Archean metavolcanic rocks in the northeast portion of the northern map area occur as bands that are generally less than 100 m wide and interlayered with the metasedimentary rocks (*see* Figure 2). The best exposures are along the trail east of Black Sturgeon Lake, with minor units in the area between Magee and Frazer lakes. A single band approximately 1 km wide extends from east of Black Sturgeon Lake to northeast of Ferguson Lake(*see* Map P.3538). These rocks are medium- to fine-grained, dark green, consisting of plagioclase and amphibole that are highly deformed with foliated gabbroic to gneissic textures, and generally metamorphosed to regional amphibolite facies. Although interpreted to be mafic metavolcanic rocks, the lack of primary textures and the high degree of metamorphism and deformation suggest that some of these units may be metamorphosed mafic intrusive rocks. These rocks are interpreted to correlate with the southern volcanic sub-belt of the Beardmore–Geraldton Belt to the east and the Max Lake greenstone belt to the west and mark the southern limit of the Wabigoon Subprovince.

Oxide-Facies Iron Formation (Magnetite-Chert)

A magnetite-chert iron formation is exposed and interbedded with the clastic metasedimentary rocks east of Black Sturgeon Lake (*see* Figure 2). The iron formation consists of 1 to 5 cm thick bands composed of quartz or amphibole-garnet-magnetite forming a unit ranging from less than 1 to 3 m in width. Individual bands are discontinuous suggesting shearing parallel to the bands and the unit appears to be isoclinally folded. Garnet porphyroblasts are brownish red, subhedral and form crystals up to 4 cm in diameter or aggregates of smaller crystals that appear to have been rotated within the schistose matrix of amphibole and quartz.

Figure 3. Airborne total magnetic field in the northern Black Sturgeon River area.

Results of the aeromagnetic survey indicates that there are at least 2 additional iron formation horizons located to the south of the bedrock exposures, with a subparallel northeast trend (Ontario Geological Survey 2004) (Figures 2 and 3). These iron formations continue to the southwest on the west side of Black Sturgeon Lake, and to the northeast under the diabase sill. The iron formations appear to correlate with the iron formations of the Beardmore–Geraldton Belt as has been suggested by previous workers (e.g., Sutcliffe 1986). However, the exposed iron formation has a higher chert and lower magnetite content than the iron formations hosted by metasedimentary rocks in the Beardmore area, although the character of the two units to the south is not known. The exposed iron formation is very similar in character to the description of the iron formation in the Mawn Lake area by Coates (1972). Correlation of these rocks with the iron formations of the Beardmore–Geraldton Belt is in agreement with the southern boundary of the Wabigoon Subprovince being located to the south of the iron formations.

Clastic Metasedimentary Rocks

Metasedimentary rocks are exposed along the east side of the map area, east of Black Sturgeon Lake and the Black Sturgeon River (*see* Figure 2). These rocks generally consist of metamorphosed feldspathic wacke, lithic wacke, and siltstone, but also include less than 100 m wide gneissic to migmatitic bands south of Roland Lake and south of Magee Lake. The metawackes and metasiltstones are light greyish brown to medium grey, with 3 to 30 cm thick beds, and a schistosity parallel to bedding resulting in the variable preservation of original textures. These units commonly contain 5 to 10% biotite, and trace to 1% very fine-grained garnet, that appear to increase in abundance toward the south suggesting an increase in the regional metamorphic grade. The exception to this southward increase is the amphibolite-grade metamorphism in the area of the iron formation, east of Black Sturgeon Lake.

In the area south and west of Magee Lake, metamorphism has resulted in the formation of andalusite schists (*see* Figure 2). Specific bands of metasedimentary rocks composed of individual to multiple beds contain 10 to 15% coarse- to very coarse-grained, subhedral to euhedral andalusite. A fine-grained, subhedral mineral tentatively identified as cordierite also occurs in these same bands. The andalusite occurs disseminated through some beds and occasional concentrated along parallel bands that appear to represent the original bedding plane. This distribution probably reflects the distribution of clay minerals, with higher Al_2O_3 content, within the wackes.

The gneissic to migmatitic bands south of Roland Lake and Magee Lake have transitional contacts with the metasedimentary rocks (*see* Map P.3538). These bands are composed of black to grey, fine-grained quartz, biotite, plagioclase rocks that are intruded along the schistosity by leucocratic dikes of the biotite granite suite. The dikes may be only 2 to 3 cm wide and boudinaged suggesting intrusion or formation early in the deformation event (Photo 1). The gneissic bands are also distinguished from the other metasedimentary rocks by the presence of 20 to 25% biotite. The dikes may represent partial melting of the metasedimentary rocks, or could be part of the felsic intrusion suite best exposed between Magee Lake and the Black Sturgeon River.

The metasedimentary rocks of this map area closely resemble the clastic metasedimentary rocks of the Quetico and Wabigoon subprovinces in the Beardmore area, east of Lake Nipigon. For this reason, these rocks are interpreted to have accumulated in a trench environment of an accretionary complex comparable to the depositional environment of the Beardmore–Geraldton Belt (e.g., Williams 1989). The interpreted increase in metamorphic grade toward the south may reflect the transition from the southern Wabigoon Subprovince to the Quetico Subprovince, and would be in agreement with the location of the iron formations within the southern metasedimentary sub-belt, Beardmore–Geraldton Belt, Wabigoon Subprovince (e.g., Hart, terMeer and Jolette 2002).

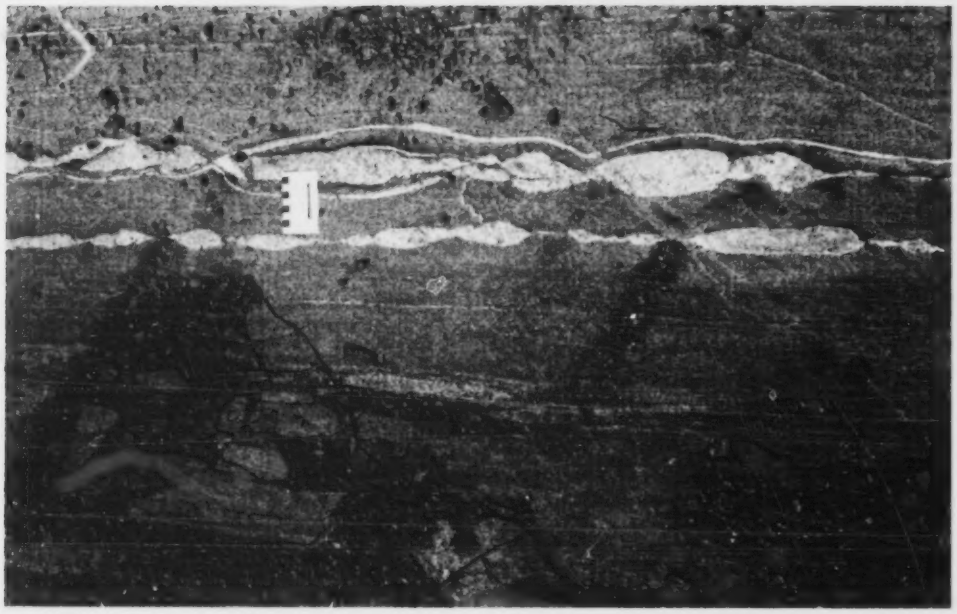

Photo 1. Boudinaged leucocratic biotite tonalite dikelets in quartz-biotite-plagioclase schist of the Quetico Subprovince, along the Church Road (station 1061).

Photo 2. Graphic tourmaline–quartz intergrowth in a pegmatitic muscovite granite dike along the logging road east of the Black Sturgeon River (station 65). Coin is 2.1 cm in diameter.

Syntectonic Mafic Intrusive Rocks

Two mafic sills intrude the metasedimentary rocks in the area east of Black Sturgeon Lake, but are too small to be properly displayed at 1:50 000 scale on Preliminary Map P.3538 (*see* back pocket). The sills are massive, medium- to very coarse-grained, white to dark green and composed of plagioclase and amphibole. The best example is located in the trenches of the Black Sturgeon Lake uranium occurrence. The sills are metamorphosed, but relatively undeformed, and the schistosity of the surrounding metasedimentary rocks drape around the sills.

Felsic Intrusive Rocks

The felsic intrusive rocks in the map area have been tentatively subdivided into 3 suites, biotite tonalite, muscovite granite and hornblende suite, based on their field characteristics. The ages of these suites are not known and there is the possibility that they may be petrogenetically related. All of these suites intrude the metasedimentary rocks of the Quetico Subprovince, to a lesser extent the rocks of the Wabigoon Subprovince, and are intruded by the Nipigon diabase sills.

The biotite tonalite suite generally occurs as dikes ranging from a few centimetres to a few metres in width in the area east of the Black Sturgeon River (*see* Map P.3538). Rocks of this suite typically contains less than 10% biotite, which is the only mafic mineral, and the biotite is usually most common along the contacts of the bodies. In many cases, the rocks classified as dikes are composed entirely of quartz and plagioclase, with the biotite along the contacts possibly assimilated from the surrounding country rock. The dikes are aphanitic to medium-grained, massive to weakly foliated intruding along the schistosity of the metasedimentary and metavolcanic rocks, and best describe the felsic material in the gneissic to migmatite units. Southeast of Nonwatinose Lake, a massive to weakly foliated, medium-grained, biotite-muscovite granite forms a topographic high. This granite contains occasional xenoliths of the metasedimentary rocks, and is intruded by numerous dikes of pegmatitic muscovite leucogranite.

Muscovite granite dikes and leucocratic granite bodies occur in the area east of the Black Sturgeon River (*see* Map P.3538). The numerous muscovite granite dikes are commonly 2 to 10 m wide, but may be up to 25 m wide and intrude along the foliation of the metasedimentary rocks, in the area east of Nonwatin and Nonwatinose lakes. The dikes are composed of pegmatitic quartz, potassium feldspar and plagioclase and frequently contain graphic intergrowths of quartz and feldspar. Some dikes contain black, coarse-grained to pegmatitic, tabular tourmaline usually graphically intergrown with quartz (Photo 2). Trace to 2%, fine-grained, disseminated, subhedral, reddish brown garnet was identified in a few of the dikes. A single dike located along the logging road east of the Black Sturgeon River (*see* Map P.3538) contains plumose intergrowths of muscovite-quartz. The composition and grain size of the dikes appears to vary along their strike length, over distances of 25 to 50 m, resulting in an erratic, patchy distribution of the tourmaline, muscovite and garnet. The leucocratic granites form irregular bodies greater than 25 m in width composed entirely of quartz, potassium feldspar and plagioclase with ubiquitous graphic intergrowths of quartz and feldspar. These granites contain trace to 1% fine-grained biotite along their margin, and the biotite is assumed to have been assimilated from the surrounding country rocks. The large areas marked as muscovite granite on the maps are based on the magnetic and radiometric geophysical response (Figures 3 and 4; Ontario Geological Survey 2004), and delineated areas interpreted to be composed predominantly of granite interlayered with metasedimentary rocks.

The hornblende granite occurs as a dike-like body approximately 20 m wide intruding along the fabric of the metasedimentary rocks in the area south of Roland Lake (*see* Map P.3538). The granite is medium to coarse grained, massive and composed of quartz, potassium feldspar and plagioclase with

about 10% subhedral hornblende. The granite is moderately to intensely sericitized in an irregular pattern. Shearing occurs along the southern contact and granite is brecciated with hematite and specular hematite. The relative age of this unit is not known, as it is not observed in contact with the other felsic intrusive rocks.

Figure 4. Airborne gamma-ray spectrometer Survey K Response for the northern Black Sturgeon River area.

PROTEROZOIC

Diabase Dikes

North-striking, 5 to 10 m wide diabase dikes intrude metasedimentary and metavolcanic rocks in the area east of the Black Sturgeon River (*see* Map P.3538). The dikes are medium to dark green, fine- to medium-grained, massive, gabbroic-textured rocks with aphanitic chilled margins. Most dikes are plagioclase porphyritic, with white, subhedral, medium- to coarse-grained, disseminated plagioclase. Epidote and hematite alteration is commonly observed near the margins of the dikes and in the surrounding country rocks forming irregular 2 to 3 m wide alteration zones. The timing of the alteration is not known, but it may be related to the intrusion of the dikes. Similar alteration is associated with the diabase dikes in the Beardmore area (Hart, terMeer and Jolette 2002; Benedict and Titcomb 1947). The contact of a dike exposed east of Ferguson Lake is irregular and displays a sinistral offset correlating with the fabric of the adjacent metasedimentary rocks indicating pre-deformation to syn-deformation emplacement. Based on the higher metamorphic grade and the deformation of the contact, these dikes have been classified as part of a Paleoproterozoic intrusive event. The north-strike of the dikes would suggest that they are part of the Marathon dike swarm (2101 to 2121 Ma) (e.g., Davis and Stott 2003). However, recent studies in the Beardmore area suggest that some of the north-trending dikes may either be Marathon diabase metamorphosed by the Nipigon diabase sills or part of the Keweenawan intrusive event and possibly related to the Nipigon diabase sills (Halls and Stott 2003).

Sibley Group Sedimentary Rocks

The Sibley Group sedimentary rocks have been subdivided into 3 relatively flat-lying formations: the lower Pass Lake, the middle Rossport, and the upper Kama Hill (Franklin et al. 1980; Cheadle 1986). The interpreted depositional environment for the Rossport Formation is a periodically flooded playa lake, overlain by distal alluvial floodplains of the Kama Hill Formation in a shallow northwest-trending basin (e.g., Cheadle 1986). The sedimentation processes probably resulted in an irregular depositional surface on the scale of an outcrop, such that, although the bedding is generally flat-lying, the orientation may be variable (P. Fralick and B. Rogala, Lakehead University, personal communication, 2003). These formations unconformably overly the Archean metavolcanic and metasedimentary rocks of the southern Wabigoon and Quetico subprovinces, and are intruded by the Keweenawan Nipigon diabase sills. The best isotopic age determination available to date is a Rb/Sr age of 1339±33 Ma, expressed using current decay constants, based on analyses of a combination of Rossport and Kama Hill formation samples by Franklin (1978). The sedimentary rocks are weakly deformed and often contain chlorite and amphibole as a result of hornfels-facies metamorphism by the diabase sills and peridotites.

PASS LAKE FORMATION

The Pass Lake Formation consists of basal conglomerate and upward-thinning beds of quartz arenite with minor dolomite beds (Franklin et al. 1980). The formation consists of a lower laterally discontinuous, clast- to matrix-supported conglomerate overlain by upward-fining sandstone to quartz arenites with minor thin interbeds of dolomitic mudstone and siltstone with a total thickness ranging from 0 to 100 m (Metsaranta, Fralick and Rogala 2003). This formation is not exposed in the map area, but was intersected near the base of a number of diamond drill holes (e.g., ST02-01).

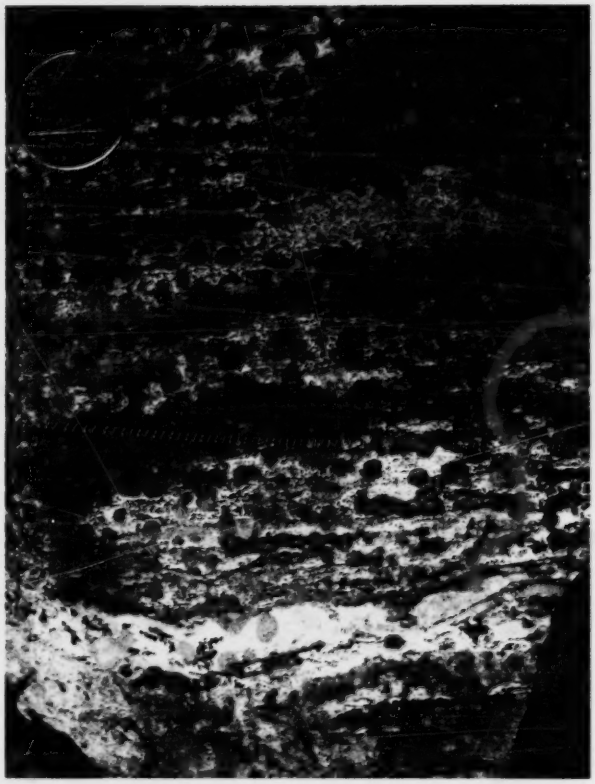

Photo 3. Hornfels facies metamorphism in the carbonatized Sibley Group sedimentary rocks (station 1097). Coin is 2.1 cm in diameter.

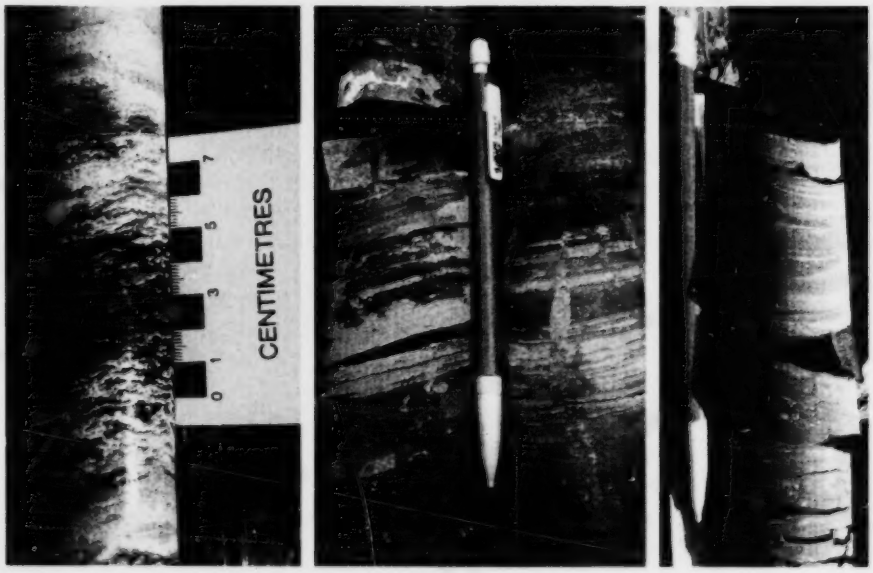

Photo 4. Cross laminations and gypsum solution cavities in red siltstones of the Rossport Formation, Sibley Group from diamond-drill holes (from left to right) SR02-01-87m (northeast of Disraeli Lake), D00-04-44.98m and D00-01-12.71m (both south of Disraeli Lake)). Size of pencil is approximately 15 cm.

ROSSPORT FORMATION

The Rossport Formation may disconformably overlie, or have a transitional contact with, the Pass Lake Formation (Metsaranta, Fralick and Rogala 2003) and is subdivided into the lower Channel Island, middle Middlebrun Bay and upper Fire Hill members (Cheadle 1986). Estimates of the maximum thickness of the Rossport Formation vary with 134 m at its type locality to 300 m thick north of the Town of Nipigon (Fralick, Smyk and Mailman 2000), with recent work by Rogala (2003) proposing an average thickness of 100 m. The total thickness in the map area may be up to 400 m based on diamond drill intersections, although the same intervals contain approximately 300 m of diabase sill so that the original thickness is not accurately known (*see* Map P.3540, Cross Sections A–A′ and B–B′, back pocket).

Cyclic or rhythmically layered, purple brown mudstone–dolomite or mudstone–sandstone couplets with siltstone, limestone and rare stromatolite layers of the Channel Island Member are not exposed in the south-central map area, but are intersected in several diamond-drill holes. These sections are generally contact metamorphosed (hornfels) by the intruding diabase sills and there are few primary structures preserved with the exception of graded bedding, upright flame structures and slump structures in sandstone layers. Hornfels metamorphism of the carbonate-rich units is common producing a calc-silicate mineral assemblage of light green to grey serpentine, calcite, biotite (phlogopite), talc and magnetite (e.g., Photo 3). Chlorite, amphibole and epidote may also be present.

The Middlebrun Bay Member is a stromatolite facies in the middle Rossport Formation, which is not present in all areas, and is reported to be between 80 and 140 cm thick (Fralick, Smyk and Mailman 2000). This member is exposed in the rubble along the side of the Mawn Road, south of Shillabeer Lake. In this location, the member consists of ovoids that are a few centimetres in diameter, but occasionally are up to a few tens of centimetres in size, that have been identified as domal growth structures of chert-carbonate cryptalgal laminite (Cheadle 1986). Samples are grey to light grey green suggesting metamorphism of the chert-carbonate by a diabase sill. Rubble of stromatolitic limestone is exposed along a logging road west of Disraeli Lake. In that location, the algal ovoids are generally 5 to 10 cm in diameter and samples are light grey brown to grey suggesting little to no metamorphism. A carbonate breccia unit is exposed on the east side of the Black Sturgeon River west of Magee Lake. This breccia is predominantly monolithic, with angular clasts displaying a jigsaw pattern, and it may represent a brecciated example of the stromatolite facies, but could also be an expression of the fault activity in this general area.

Red, muddy, variably carbonatized siltstones and mudstones with less common limestone, dolomite, sandstone and rare conglomerate compose the Fire Hill Member. This member is generally shallowly dipping to flat lying and the most common sedimentary structures in outcrop are mud cracks, mud flakes, reduction spheres, and solution cavities containing gypsum or calcite. Graded bedding and cross-bedding have been described in sandstone layers exposed in diamond-drill holes. Carbonatization is variable, but generally weak. In diamond-drill core, the fine bedding and cross bedding of the mudstones can be observed (Photo 4). Minor reduction of the oxidized sediments and the occurrence of gypsum along fractures and in solution cavities is common. An intraformational conglomerate and/or debris flow forms the discontinuous unit at the base of this member (Metsaranta, Fralick and Rogala 2003). This debris flow is composed of subangular clasts of mudstone, siltstone, sandstone and dolomitic limestone up to 50 cm thick that appears to be matrix supported. Examples of the debris flow are exposed along the Mawn Road southwest of Shillabeer Lake and on the pipeline northwest of Leckie Lake (*see* Map P.3539, back pocket). Along the pipeline, there are examples in the rubble of reduced, grey debris flow, in contrast to the normal red oxidized flow, which is probably a result of metamorphism by the adjacent diabase sill.

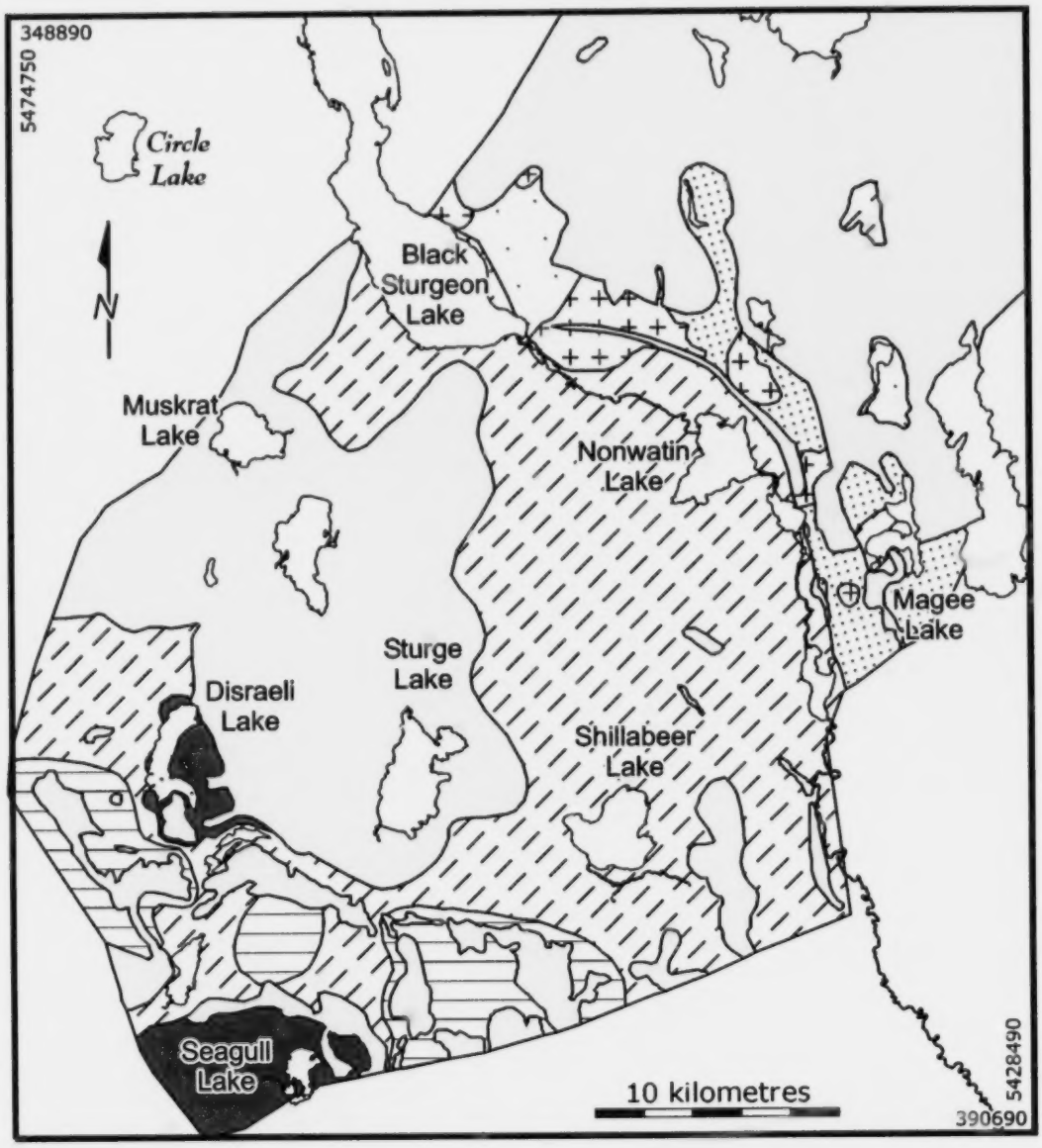

Figure 5. Possible distribution of the Kama Hill Formation in the northern Black Sturgeon River map area.

KAMA HILL FORMATION

The Kama Hill Formation consists of laminated mudstones with less arkosic siltstones and sandstones with an average thickness estimated by Rogala (2003) to be about 25 m. This formation is best distinguished from the Rossport Formation by an absence, to near absence, of carbonate. The shales are commonly deep red to reddish purple with mud cracks and ripple marks, and frequent reduction spots. Siltstones are buff to reddish brown and form more massive 20 to 30 cm beds interbedded with the shales in the area of Seagull Lake. Graded bedding and cross bedding are also present in sandstone and siltstone layers. Exposures of Kama Hill Formation are generally observed at higher elevations in the southwestern portion of the south-central map area, although some examples occur in the area southeast of Shillabeer Lake (Figure 5). There is a possibility that the stromatolitic limestone rubble located west of Disraeli Lake is a portion of the stromatolite horizon reported by Cheadle (1986) near the base of this formation.

Mafic to Ultramafic Intrusive Rocks

Two ultramafic intrusions occur in the map area: one at Disraeli Lake and the other in the Seagull–Leckie lakes area (*see* Figure 2). These rocks intrude Sibley Group and Quetico Subprovince rocks and are, in turn, intruded by diabase sills. Both intrusions are composed of a pyroxene peridotite core with an irregular zone of olivine gabbro and minor monzogabbro along the margins of the intrusions.

DISRAELI INTRUSION

The pyroxene peridotite of the Disraeli intrusion is medium to coarse grained, massive, dark green to greenish black and composed predominantly of olivine and pyroxene with less than 10% plagioclase and 1 to 2% reddish brown mica. In diamond-drill core, the peridotite is massive to poikilitic textured. Outcrops of the peridotite generally have very low relief and are deeply weathered resulting in a pebbly black sand regolith. Minor serpentine is present along fractures and, in one outcrop, a set of fine, parallel, regularly spaced serpentine-filled fractures resemble layering (Photo 5). The best exposures are in the

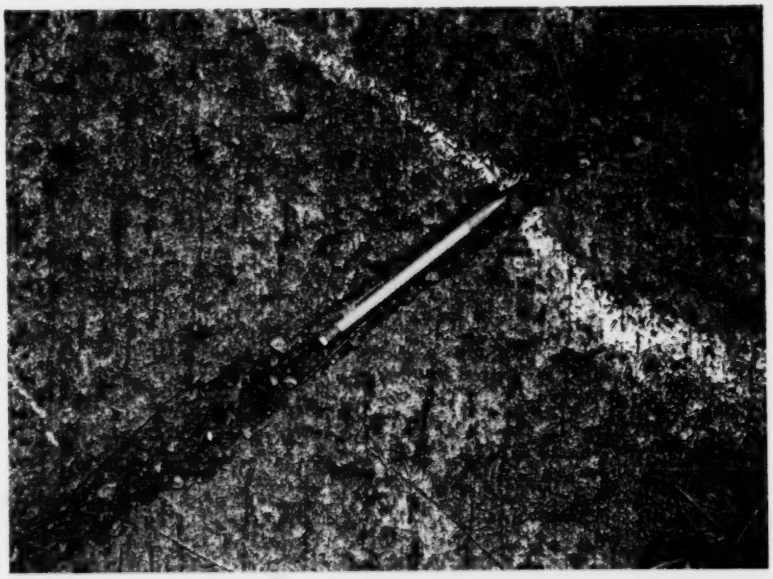

Photo 5. Parallel fractures filled with serpentine and minor biotite in the olivine gabbro of the Disraeli intrusion (station 538). Size of pencil is approximately 15 cm.

cliffs along the east side of Disraeli Lake and at higher elevations on the northeast side of the lake. Contacts between the peridotite and olivine gabbro are not exposed in outcrop. In diamond-drill core, the contact is gradual, with an apparent decrease in grain size from the peridotite to the olivine gabbro. Peridotite may occur as bands or blocks in the olivine gabbro.

Olivine gabbro is fine to medium grained, massive, composed of pyroxene, and plagioclase, with up to 20% olivine and 1 to 2% reddish brown mica. This rock type is best distinguished from the peridotite by the finer grain size and lower olivine but higher plagioclase content. The gabbro forms an irregularly distributed zone that overlies the peridotite at higher elevations on the southeast side of Disraeli Lake, and is the only lithology intersected in diamond-drill holes D00-02 and D00-03 located south of the lake (Map P.3539). Contacts between the olivine gabbro and the diabase were generally not observed in drill core, with the exception of a fine-grained to aphanitic chilled diabase intersected at an oblique angle in D00-05. Minor amounts of pink feldspar may be present in the olivine gabbro close to the contacts with the Sibley Group sedimentary rocks and near the monzogabbro.

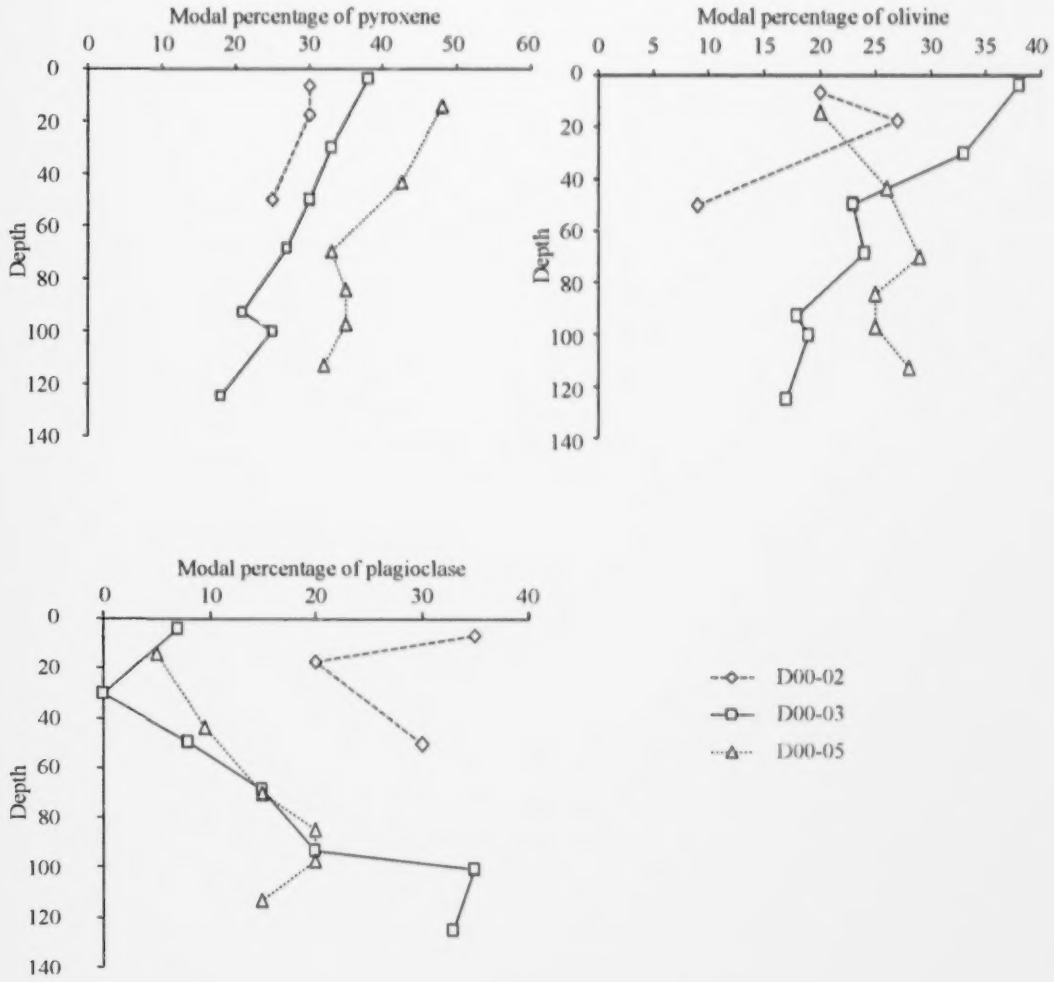

Figure 6. Modal mineralogy in diamond-drill holes D00-02, D00-03 and D00-05 through the Disraeli intrusion.

The monzogabbro occurs as irregular pods or bands ranging from a few tens of centimetres to a few metres in width of variable appearance, but distinguished from the olivine gabbro by the presence of amphibole and abundant pink feldspar. One type of monzogabbro is fine grained with commonly sharp contacts and narrow width. The other more common type is medium to coarse grained, with gradual contacts, that generally resembles the olivine gabbro. The monzogabbro usually occurs near contacts with the country rock, but is not observed in contact with the country rocks. Petrographic examinations indicate that the pink feldspar in the monzogabbro is altered plagioclase with typical plagioclase twinning containing fine-grained hematite. Petrographic examination of the finer grained, sharp contact bands indicates that they may be igneous-textured inclusions and/or layers composed of potassium feldspar, quartz, sphene, amphibole, epidote and pyroxene.

Petrographic examination indicates that the rocks of the Disraeli intrusion range in composition from olivine gabbro to plagioclase-bearing olivine clinopyroxenite and wehrlite. They are composed of clinopyroxene (10 to 48%), olivine (0 to 38%), plagioclase (4 to 35%), amphibole (0 to 27%), biotite (0 to 20%), magnetite (0 to 15%), with minor amounts of orthopyroxene and trace amounts of sulphide minerals. The rocks range from fine to medium grained, with anhedral plagioclase oikocrysts enclosing subhedral to euhedral olivine, pyroxene and magnetite. The order of crystallization is

olivine → (orthopyroxene →) clinopyroxene → magnetite → amphibole → biotite → plagioclase

Initial examination suggests that generally there is a gradual change from a central peridotite to a border olivine gabbro (e.g., diamond-drill hole D00-02). This variation reflects an increase in plagioclase and decrease in pyroxene and olivine contents (Figure 6).

SEAGULL INTRUSION

The ultramafic portion of the Seagull intrusion is exposed in the northwest portion of the body, between Seagull and Leckie lakes (*see* Map P.3539). The intrusion has a maximum thickness of 730 m, estimated from diamond-drill holes, and most of this thickness consists of ultramafic rocks. The main rock type in the intrusion is pyroxene peridotite, which is medium to coarse grained, massive, often ophitic textured, composed of predominantly olivine and pyroxene with less than 10% plagioclase and 1 to 2% reddish brown mica resembling the Disraeli intrusion. Alteration, represented by serpentine, magnetite and minor biotite, occurs along fractures, which would account for the higher magnetic response of this unit in the airborne magnetometer survey. Petrography of the peridotite has been studied in detail by G. Heggie (e.g., Heggie and Hollings, 2004) and the following lithologic information are taken from those studies. The peridotite consists of cumulate-textured dunites, lherzolites, and olivine websterite, with minor olivine-hornblende pyroxenite. Scanning electron microscope, energy dispersive analyses of olivine, pyroxene, and oxide minerals throughout the intrusion show only minor variations in compositions. The best example is observed in the olivine compositions that are Fo_{80}–Fo_{89}, based on 737 analyses. An initial subdivision of the intrusion has been proposed, based on subtle variations in the rare earth element and high field strength elements (HFSE), into a basal unit, an overlying sub-main unit and a main unit. Mineralized zones are present in all 3 units, but the most significant mineralization is restricted to the basal and sub-main units (*see* "Mineralization"). Intense hematization of the peridotite occurs in a number of highly fractured intervals in the diamond-drill core, and is interpreted to be related to regional structures that cut the intrusion (*see* "Alteration"). A diabase sill cuts the upper portion of the main body of the intrusion, but 2 smaller sills were intersected in the most westerly hole (WM98-04).

Olivine gabbro is exposed in a number of outcrops along the logging roads north and west of Seagull Lake, and is present in a number of diamond-drill holes of the Wolf Mountain property of East West Resource Corp.–Avalon Ventures joint venture. The gabbro is medium grained, massive, dark green and composed of pyroxene and plagioclase with 15 to 20% olivine and 1 to 2% reddish brown biotite. Many

Photo 6. Massive medium-grained olivine gabbro overlying peridotite of the Seagull intrusion, along the logging road northwest of Seagull Lake (station 582). The size of handle is approximately 30 cm.

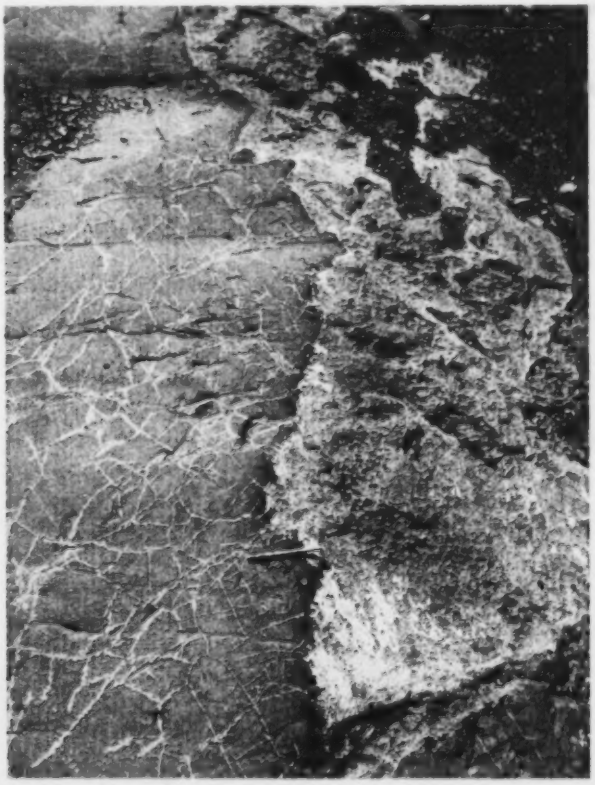

Photo 7. Chilled polygonal jointed diabase sill in contact with olivine gabbro of the Seagull intrusion, north of Seagull Lake (station 561). The size of pencil is approximately 15 cm.

of the contact relationships with the peridotite and monzogabbro are similar to those described for the Disraeli intrusion. The olivine gabbro is observed to overlie the peridotite in one outcrop (Photo 6), but the peridotite was too strongly weathered for more than a cursory examination. A diabase sill chilled against the olivine gabbro is exposed in a number of outcrops northeast of Seagull Lake, providing a relative age relationship (Photo 7).

Monzogabbro is observed in outcrops along the logging road northwest of Seagull Lake and in the upper portion of a number of diamond-drill holes. It is fine to coarse grained and massive, with a variable amphibole content and a distinctive pink feldspar or groundmass. This rock type occurs as irregular bands or pods ranging from a few centimetres to a few metres in width with sharper contacts for the finer grained phases and gradual contacts for the coarser grained examples. The monzogabbro occurs close to the contacts between the intrusion and the country rocks.

Nipigon Diabase Sill Complex

A series of undulating, generally flat-lying to shallow-dipping Proterozoic diabase sills intrude all other lithologies in the map area. The sills often form topographic highs as they are more resistant to weathering, but they also intrude the Sibley Group sedimentary rocks between Sturge Lake and the Black Sturgeon River. Davis and Sutcliffe (1985) obtained a U/Pb age of 1109+4/–2 Ma, based on zircon and baddeleyite, from 2 sills on Lake Nipigon, indicating that the sills are the youngest rock unit in the map area.

The diabase sills are commonly composed of medium brown to grey brown, massive, medium- to coarse-grained feldspar and pyroxene with trace to 3% fine-grained olivine and 1 to 2% magnetite. Internal subdivision of the diabase varies from diamond-drill hole to diamond-drill hole, and not all of the lithologies are exposed in one stratigraphic section whether in a diamond-drill hole or outcrop. However, the internal subdivision resembles those proposed by Sutcliffe (1986). A generalized section of a sill would contain 1) chill, 2) fine-grained variably amygdaloidal, 3) magnetite-rich, 4) medium to coarse grained, 5) coarse to very coarse grained, 6) fine-grained, variably amygdaloidal, and 7) chill. The chill margins have a varied character depending on the nature of the adjacent country rock, as discussed below. The fine-grained sub-ophitic diabase, upper or lower portions, generally extends for about 0.5 m from the chill margins, contains a higher percentage of amygdules where the chill is inclusion rich. Layering may also occur in this unit, and is discussed in detail below. Locally, fine- to medium-grained plagioclase laths are aligned subparallel to the sill contact in medium-grained diabase, and are interpreted to be a flow foliation indicating that some portions of the sills had a dynamic cooling history. Magnetite-rich diabase is present in some sections and contains up to 15% macroscopic magnetite in medium- to coarse-grained, massive diabase. This unit is equivalent to the magnetite porphyritic diabase observed in the Beardmore area by Hart, terMeer and Jolette (2002). Medium- to coarse-grained diabase forms the majority of the sills and recently exposed outcrops of the coarse-grained diabase may appear leucocratic. Coarse- to very coarse-grained diabase appears to be more common toward the centre of the sills and has gradual contacts with the medium-grained diabase. The medium- to very coarse-grained diabase lacks a sub-ophitic or diabasic texture and should properly be classified as gabbro, but to avoid confusion with other intrusions in the area, the diabase classification has been applied to all rocks associated with the sills. Ophitic textures are most prominent in the coarse- to very coarse-grained lithologies, with pyroxene oikocrysts up to 2 cm in diameter (Photo 8). However, in drill hole SR02-01, there are multiple intervals of very coarse-grained, ophitic diabase in the lower portion of the sill interbanded with massive coarse-grained diabase that define a crude layering. This indicates a complex cooling history or injection of more than one phase of magma into the sills. Identification of the different units is difficult on weathered outcrops and, in many cases, is only possible on the exposures created during the construction of recent logging roads.

A very coarse-grained unit composed of amphibole-plagioclase±potassium feldspar occurs as irregular patches with very sharp boundaries or joint fillings in the upper portion of the sills (Photo 9). The amphibole varies in composition from hornblende to actinolite and it is up to 6 cm in length in some joint fillings. Many patches, or pods, contain only plagioclase, but some contain up to 30% pink feldspar that may be a potassium feldspar or hematite-stained plagioclase. The patches vary from a few centimetres in diameter, up to 1.0 m in length by 0.5 m in width, and commonly have irregular outlines in 3 dimensions. This unit is equivalent to the pegmatoidal diabase described by Sutcliffe (1982, 1986). Hosted by medium- to coarse-grained diabase, the patches are interpreted to represent a late magmatic phase by Sutcliffe (1986). The joint fillings may have crystals oriented perpendicular to the joint edge and weak alteration of the adjacent diabase suggesting that they formed as a subsolidus alteration.

Layering is observed in a few outcrops that appear to overlie coarse-grained diabase and underlie very fine-grained diabase suggesting it is located close to the upper contact of a sill. The layers are highly variable in width, ranging from a few centimetres to more than 50 cm (Photo 10). The boundary between layers is generally marked by a decrease in grain size from medium to fine grained across a few centimetres and a higher percentage of feldspar or the presence of coarse to very coarse-grained patches 10 to 20 cm in diameter. In one location, a layer is defined by medium- to coarse-grained magnetite (Photo 11). Very coarse-grained patches are also common within the layers and the adjacent diabase, and may have magnetite-rich margins (*see* Photos 10 and 11). These patches often have irregular shapes and more closely resemble the patches observed in the inclusion-rich diabase contact zones. The layers appear to be flat lying to very shallowly dipping, but it is difficult to accurately determine the orientation of the layers due to the glaciated nature of the outcrops.

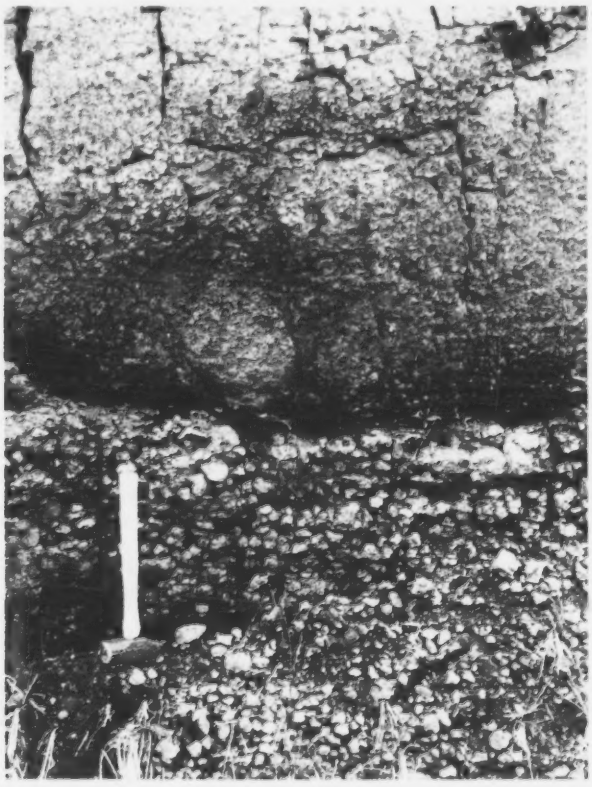

Photo 8. Coarse-grained ophitic diabase displaying variable weathering, located along the Church Road west of Frazer Lake (station 57). The size of the handle is approximately 30 cm.

Photo 9. Very coarse-grained patch of diabase containing needles of actinolite (station 1176).

Photo 10. Layering in the upper portion of a diabase sill, with rare large amygdules, located along the Church Road, southeast of Graydon Lake (station 2107). The width of notebook is 14 cm.

There are 2 general types of sill contacts that have been classified as chill and inclusion-rich chill. The most common type is an aphanitic to plagioclase porphyritic or glomeroporphyritic chill, a few centimetres in thickness that usually has a polygonal joint pattern if observed in plan view (Photo 12). They may have preserved glass and occasional subangular to subrounded, pebble- to boulder-size xenoliths of country rock. Reaction rims a few centimetres wide are common around the xenoliths, particularly xenoliths of Quetico Subprovince metasedimentary rocks, but there is no other evidence of assimilation. Alteration is also observed along joints in the chill contacts (Photo 13), and may extend into the sills for up to 1 m. The chill zones are generally 2 cm wide and the grain size increases to medium to coarse over a distance of less than a metre.

The inclusion-rich chill contact is relatively rare, and includes a number of complex zones intersected in diamond-drill core (e.g., the Bitterroot diamond-drill holes). This contact style is characterized by a fine-grained, massive, biotitic, occasionally plagioclase porphyritic diabase matrix containing abundant cavities, xenoliths and very coarse-grained patches. The cavities are irregularly shaped, up to 2 cm in diameter and usually partially filled with acicular actinolite, black biotite, and/or feldspar (Photo 14). Occasionally, the cavities are up to 15 cm in diameter with surrounding alteration rims and cut by fractures (Photo 15). Angular to subangular pebble-size xenoliths are composed of coarse-grained quartz and white to pinkish feldspar. The patches are composed of randomly oriented amphibole and feldspar up to 10 cm in diameter, but radially oriented crystals have also been observed. The patches may form part of a continuum with the cavities. The country rock is generally not observed near these contacts, except in diamond-drill core where the inclusion-rich chill is in contact with Sibley Group sedimentary rocks.

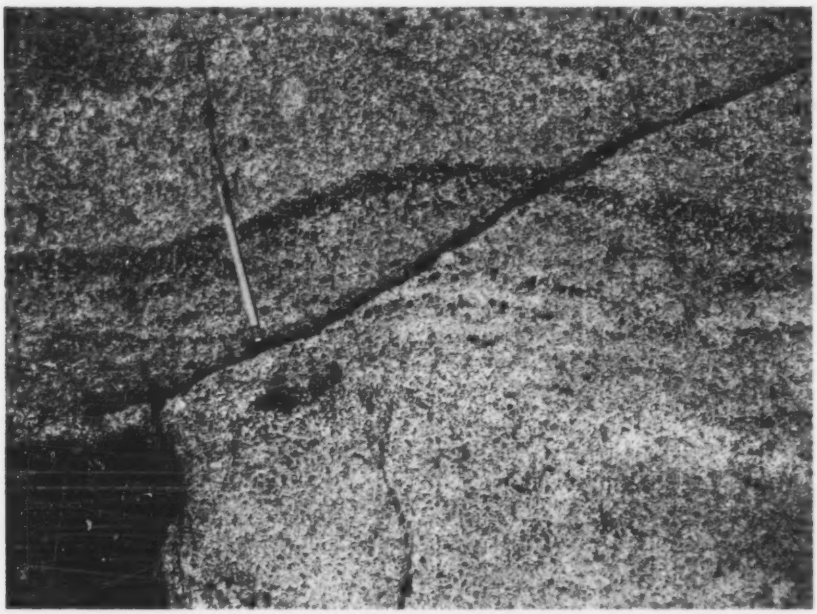

Photo 11. Magnetite layering dipping shallowly to the east in the upper portion of a sill located along the Plateau Road east of Black Sturgeon Lake (station 23). The size of pencil is approximately 15 cm.

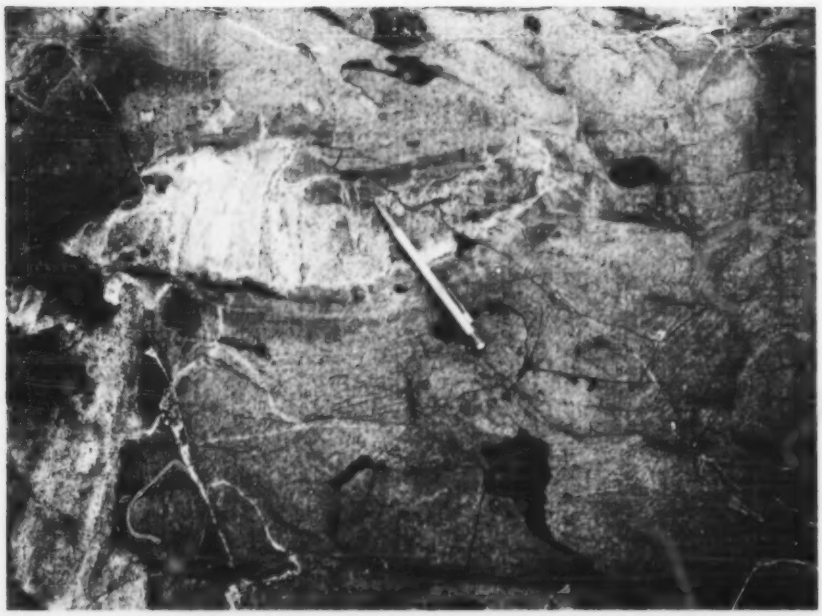

Photo 12. Xenolith of Quetico Subprovince metasedimentary rock in glassy chill with minor amygdules and zoning of the chill in bands parallel to the contact with the xenolith, near the Church Road northeast of Graydon Lake (station 54). The size of pencil is approximately 15 cm.

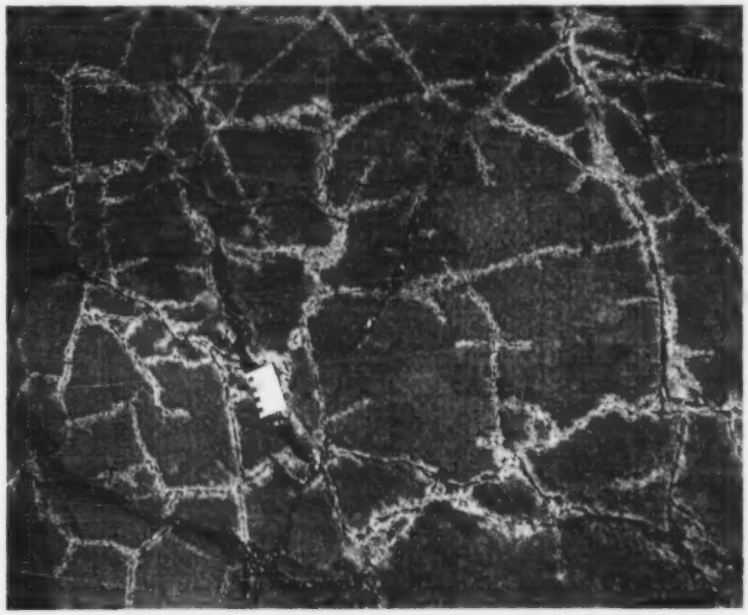

Photo 13. Polygonal chill with pink to white alteration along polygonal joints on the Church Road east of Graydon Lake (station 573).

Photo 14. Inclusion-rich chill with quartz-feldspar xenoliths and amygdules in a biotite-rich diabase matrix on the Krug Road southwest of McIntyre Bay, Lake Nipigon (station 1098).

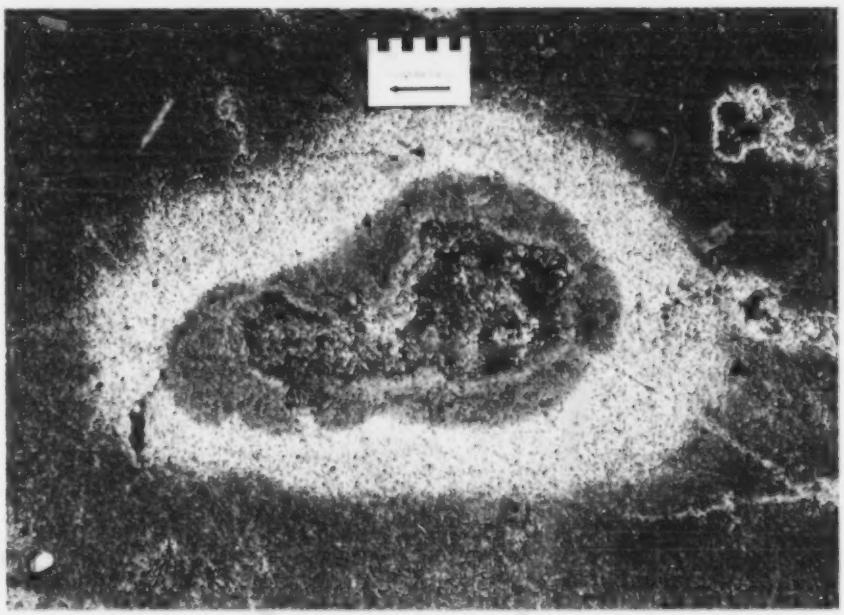

Photo 15. Large amygdule partially filled with amphibole and feldspar with a bleached alteration rim, on the Church Road west of Frazer Lake (station 1059).

The best example of the inclusion-rich chill contact is exposed in the area south of Muskrat Lake, along the northern projection of the Fox Mountain ridge. Medium- to coarse-grained diabase on the higher elevations, closer to the logging road that goes south from Black Sturgeon Lake (*see* Map P.3538), contains 3 subhorizontal irregular bands of very coarse-grained pink feldspar and amphibole up to 5 cm thick. Further downhill toward the lower contact, there are 2 poorly defined zones: one containing irregularly shaped clots of amphibole up to 10 cm in length (Photo 16) and a second zone of numerous 0.5 to 1.5 cm xenoliths of quartz and feldspar (Photo 17). Next is a zone containing abundant gas cavities that is cut by chilled dikelets 5 to 10 cm in width that contain anhedral feldspar and chlorite-filled cavities concentrated along their cores (Photo 18). Further down slope and stratigraphically below the gas cavity-rich zone is a chill contact progressing into a medium- to coarse-grained diabase. The original lower contact is interpreted to have originally been with Sibley Group sedimentary rocks, which were subsequently displaced by a later diabase sill. The total thickness of this section is difficult to determine due to the gentle downhill slope, but would appear to be between 5 and 10 m.

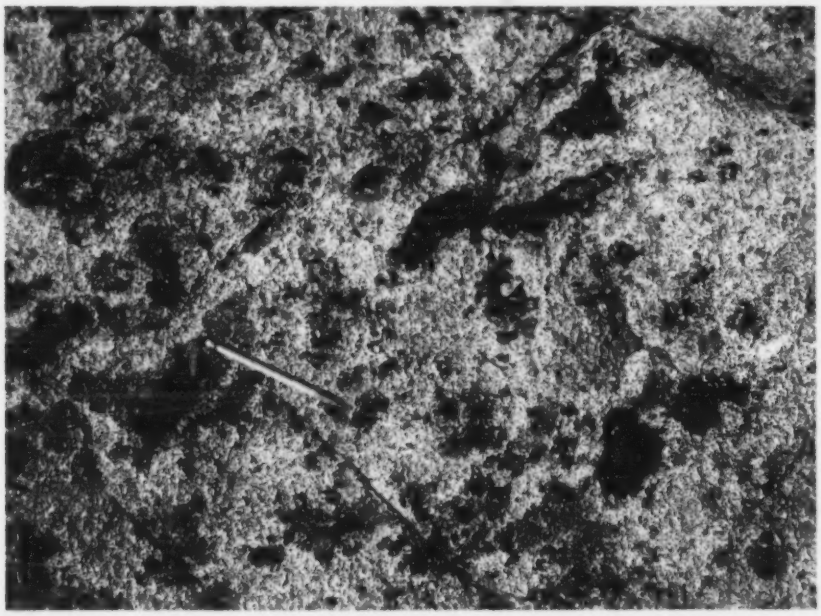

Photo 16. Irregularly shaped pods of amphibole in the inclusion-rich chill, south of Muskrat Lake (station 106). The size of pencil is approximately 15 cm.

Photo 17. Abundant pebble-size xenoliths of quartz and feldspar in a biotite-rich diabase matrix in the inclusion-rich chill south of Muskrat Lake (station 106). The size of pencil is approximately 15 cm.

Photo 18. Chilled dike with chlorite-filled amygdules cutting the inclusion-rich chill south of Muskrat Lake (station 106). The size of pencil is approximately 15 cm.

Petrographic examination of the diabase reveals that it is composed of plagioclase (24 to 52%), clinopyroxene (15 to 37%), olivine (0 to 10%), magnetite (3 to 9%), amphibole (0 to 16%), and biotite (1 to 8%). The modal percentage of pyroxene, olivine and plagioclase change fairly rapidly with depth within short distances in diamond-drill holes ST02-01 and SR02-01 (Figure 7), indicating the presence of compositional layering in the sills. The grain size ranges from very fine to coarse grained and ophitic to sub-ophitic textures and minor intergranular mineral phases. The grain size and texture vary irregularly even in centimetre scale. The order of crystallization is

plagioclase → olivine → magnetite → pyroxene

The diabase is weakly to moderately altered. The alteration minerals are serpentine, chlorite, biotite, amphibole, calcite, prehnite, minor epidote and talc, and hematite. The very coarse-grained potassium feldspar-rich patches occur interstitial to primary minerals are composed of quartz, potassium feldspar and apatite and have a granophyric texture. The amount of granophyres is up to 20%, but it is generally less than 5%. Pyroxene is partially altered to amphibole around the granophyric patches. According to Sutcliffe (1986), granophyric phases are the result of a late magmatic event, which is in agreement with the current observations.

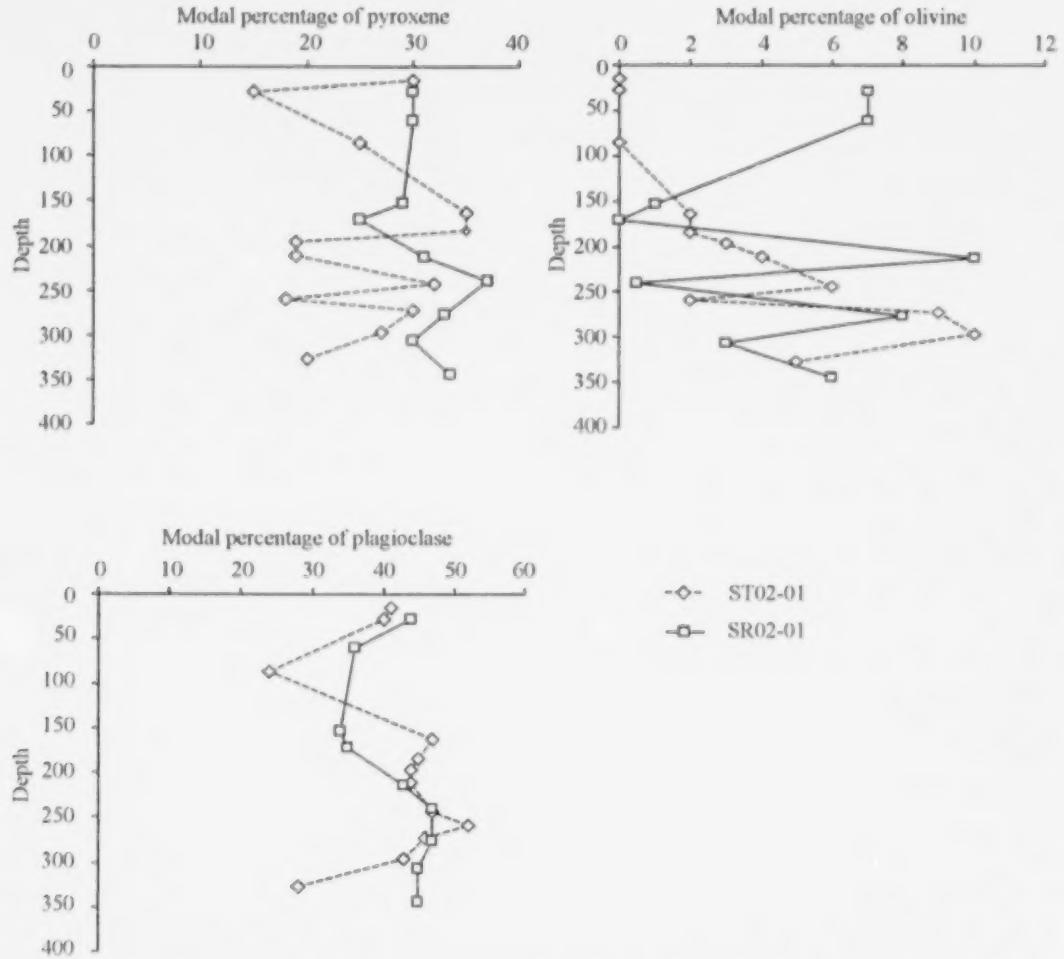

Figure 7. Modal mineralogy in diamond-drill holes SR02-01 and ST02-01 through a diabase sill.

Fox Mountain is a 50 to 90 m high, approximately 10 km long, north-trending ridge located east of Disraeli Lake. The diabase at the top of the ridge is medium- to coarse-grained, massive diabase, with minor coarse-grained, magnetite porphyritic diabase. On the west side of the ridge near the north end of Disraeli Lake, there is a series of chilled dikelets with chlorite cavities, similar to those described above in an inclusion-rich contact (*see* Photo 18), intruding the diabase. Approximately 900 m to the north of the dikelet exposures, a block of metamorphosed carbonate sedimentary rocks is in contact with chilled diabase. Apparently flat-lying contacts, east of Disraeli Lake and east of Shook Lake, contradict the Disraeli Lake contact, which indicates that a lower diabase sill is chilled against an overlying sill, and the Shook Lake contact, which indicates that the overlying sill chilled against a lower sill. The presence of carbonate sedimentary rocks near the top of the Fox Mountain ridge, may be a result of a sloping sill contact similar to those observed on a smaller scale in a number of locations (*see* "Structure"). There are a number of possible interpretations for the formation of the Fox Mountain ridge including emplacement as a dike or a contact zone between diabase sills of different ages.

Alteration

Sibley Group sedimentary rocks are intruded by the peridotite, and occasionally the diabase, resulting in the development of calc-silicate hornfels or skarn (Meinert 1992). The hornfels is variable in width extending up to 10 m into the sedimentary rocks adjacent to the intrusions and sills, although there is an approximately 60 m thick layer of sedimentary rocks between the 2 sills in diamond-drill hole ST02-01 that is variably metamorphosed throughout. The mudstone beds within the Sibley Group develop a light green, mauve, reddish grey to light grey banding (*see* Photo 3). Dolomite-rich beds form white to buff marbles. Orbicular textures in 3 to 5 cm wide zones occur along some sill contacts, and 0.2 to 0.5 cm amphibole orbs were observed in one outcrop. Sutcliffe (1986) identified talc, tremolite, serpentine and diopside in metamorphosed sedimentary rocks. Wollastonite, NaCa-zeolite minerals, actinolite and/or tremolite, and feldspar occur along joints and fractures in the diabase sills near contacts with Sibley Group possibly as a result of reactions with the sedimentary rocks, although they may be related to a later hydrothermal event. The Gresky magnetite occurrence described by Coates (1972) as 50 to 75% magnetite along the bedding plane of a limestone could suggest a potential for an iron skarn-style of mineralization (Meinert 1992). The occurrence is represented by a number of boulders of unknown origin located approximately 400 m east of Eileen Lake, and subsequent work has failed to identify this alteration *in-situ*.

Less commonly, the intrusion of the diabase sills may result in the reduction of the normally oxidized Sibley Group sedimentary rocks resulting in a light grey colour. Hornfels metamorphism of the sedimentary rocks is generally absent in these areas. In one example from Bitterroot Resources diamond-drill hole DDH-3, the reduction extends for approximately 3.5 m from the sill contact. A similar reduction of the Sibley Group is exposed in the rubble of the intraformational conglomerate cropping out along the natural gas pipeline on the western side of the map area.

The peridotite in Disraeli and Seagull intrusions is commonly deeply weathered and may be capped by a black sand regolith that is tens of centimetres thick. As a result of this deep weathering, the peridotite outcrops are generally small and relatively rare with a very low relief. Serpentine alteration after olivine is generally moderate to weak and restricted to fractures. Locally in the Disraeli Intrusion, sets of parallel fractures develop, containing serpentine and resulting in a layered appearance of the rock (*see* Photo 5). The olivine gabbro has a weathering pattern similar to the diabase, but, due to the higher olivine content, forms smaller and lower relief outcrops. Alteration is usually restricted to minor development of chlorite along fractures. The presence and abundance of pink feldspar correlates with proximity to the contact between the olivine gabbro and the Sibley Group metasedimentary rocks. The

monzogabbro occurs as irregular pods or bands ranging from a few tens of centimetres to a few metres in width of variable appearance, but distinguished from the olivine gabbro by the presence of amphibole and abundant pink feldspar. Petrographic examinations indicate that the pink feldspar in monzogabbro is altered plagioclase with typical plagioclase twinning containing fine-grained hematite. Geochemical data suggests that the pink feldspar in the olivine gabbros correlate with a higher K_2O content (*see* "Geochemistry"), and that the monzogabbro may be a product of assimilation of Sibley Group sedimentary rocks by the olivine gabbro.

Weathering in the diabase is varied, ranging from less than 1 cm to 20 cm in depth. The depth of weathering appears to be controlled by factors such as outcrop exposure, grain size and groundwater availability. The longer the diabase is exposed, generally the deeper it weathers and, in areas of recent road building, this may result in varying weathering patterns on a relatively homogeneous diabase. On outcrop exposed for the same period of time, the coarse- to very coarse-grained diabase is much more susceptible to weathering, which appears to be due to the destruction of the fine groundmass between the very coarse grains. As a result, very coarse-grained units can often be carved with a geological hammer. In low areas, or areas where flowing surface water is present, the weathering produces a distinct pebbly soil, as the oikocrysts resist the weathering process (Photo 19).

Photo 19. Weathering profile of a coarse-grained ophitic diabase exposed by construction of the Church Road, south of McIntyre Bay, Lake Nipigon (station 5004).

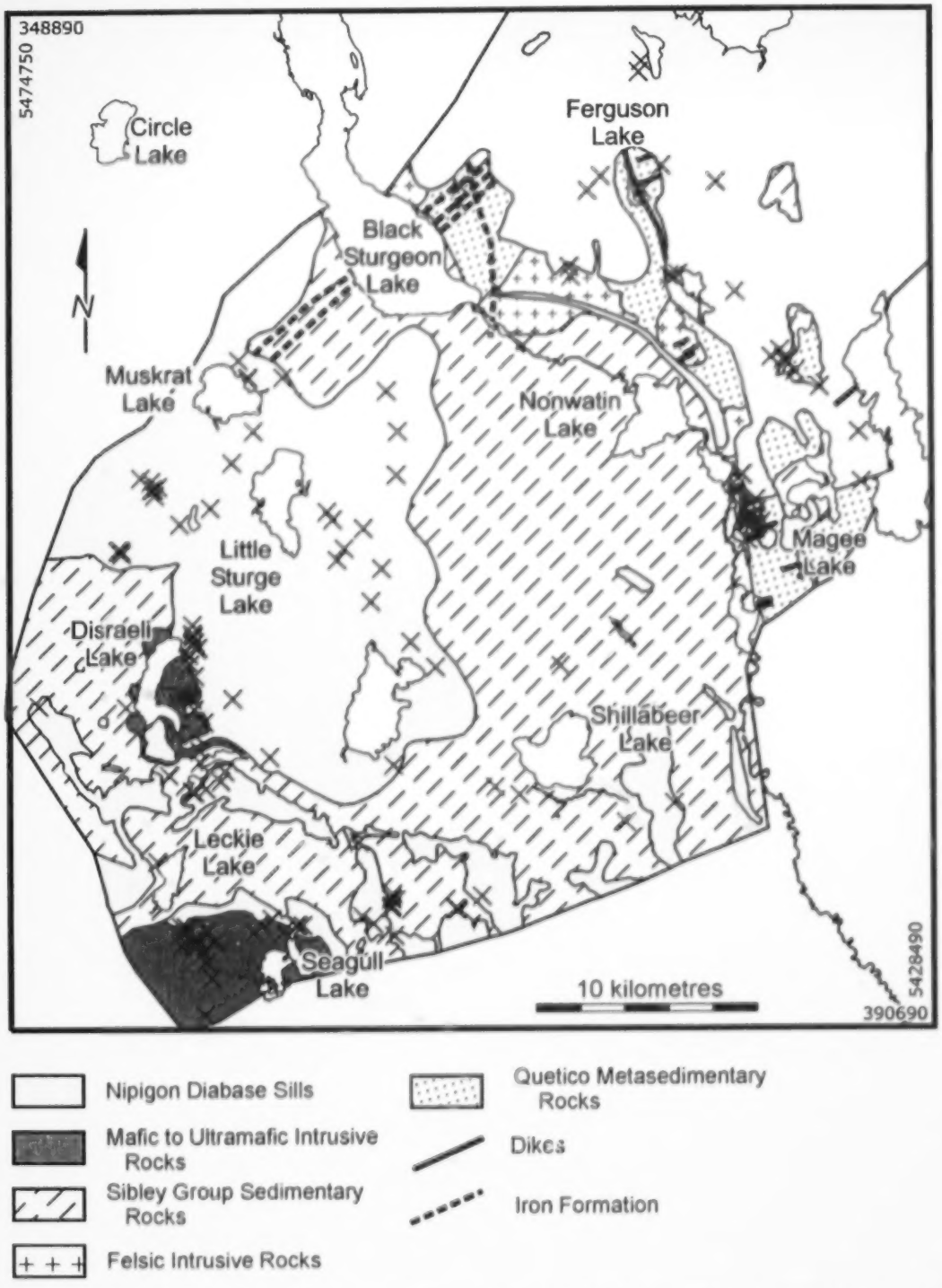

Figure 8. Distribution of lithogeochemical samples collected in 2003 and 2002 in the northern Black Sturgeon River map area (for details, *see* MRD 133).

Alteration of the diabase sills is generally restricted to joints and fractures, up to 5 cm in width, near the contacts with the country rocks. The fractures commonly contain coarse- to very coarse-grained amphibole and feldspar, rare medium-grained wollastonite, and commonly have moderately chloritized diabase margins. Good examples of this style of alteration are exposed along the Church Road in the area east of Graydon Lake. A light pinkish grey alteration may occur along less than 0.5 cm wide cooling joints for up to 1.0 m into the adjacent diabase along some diabase–Sibley Group contacts. The best example of this alteration is an outcrop located at about 49 km on the Church Road, northeast of Graydon Lake, where highly metamorphosed Sibley Group sandstone is in contact with the diabase sill (*see* Photo 13). A white alteration halo, up to 1 cm in width, is common along the polygonal cooling joints with the wider examples occurring where the diabase is in contact with the Sibley Group. Similar white alteration has also been observed along the contact between the Seagull intrusion and a diabase sill. Cavities, or amygdules, occur in the diabase in close proximity to the sill contacts and are most common in the inclusion-rich chill contact. The amygdules may contain fine-grained acicular amphibole, biotite, feldspar and/or zeolite. Observed at both the upper and lower contacts, the presence of the amygdules appears to be controlled by the assimilation of fluid-rich or volatile-rich Sibley Group metasedimentary rocks.

Hematite alteration is commonly associated with late fracturing in both Archean and Proterozoic rocks. Metre-scale zones of intense hematization occur in highly fractured and faulted portions of the peridotite of the Seagull intrusion, resulting in distinctive patchy dark-red appearance. A good example of the hematization occurs in diamond-drill hole WM98-04 drilled by Avalon Ventures Limited, located in the northwest part of the intrusion. Intense hematization was also observed in a hornblende granite intruding the Quetico Subprovince metasedimentary rocks southeast of Graydon Lake, along the Church Lake Road. Hematite and specular hematite occurs along a northeast-trending brecciated zone close to the sheared southern contact of the granite. Moderate to intense hematite alteration was also found along the east side of Black Sturgeon Lake, and along the Black Sturgeon River in the Nonwatinose Lake area. This mineralization occurs as disseminated hematite and fracture-fillings of specular hematite in the metasedimentary rocks of the Quetico Subprovince, and is associated with a north-trending diabase dike in one location. Hematite and specular hematite is associated with uranium mineralization in the Black Sturgeon Lake and Split Rapid Dam occurrences. The hematite is closely associated with the mineralization in north-trending fractures, therefore, it appears to be a useful indicator of the north-trending fault systems in this area, where most structures are hidden by talus and glacial deposits. Further work is required to understand the timing and number of hematite alteration events and their metallogenic significance.

Geochemistry

A suite of 216 samples was analyzed for major, trace, and rare earth elements plus gold, platinum and palladium (Figure 8; *see also* MRD 133, files "geochem2002", "geochem2003"). These analyses have not been fully integrated into the current map and report due to time limitations. However, 52 reconnaissance samples were collected in this map area during the 2002 field season, and the results have been discussed in previous publications (e.g., Hart 2003). Much of the following discussion is based on the 2002 analyses.

Analytical work was completed at the Geoscience Laboratories (GeoLabs) of the Ministry of Northern Development and Mines, in Sudbury, Ontario (MRD 133). The major element and select trace element analyses were completed by X-ray fluorescence using fused glass disks and pressed powder pellets, respectively. Carbon dioxide and sulphur were analyzed by infrared spectroscopy. The rare earth elements (REE) and other trace elements (tantalum, thorium, uranium and niobium) were analyzed by inductively coupled plasma mass spectrometry (ICP–MS) from a closed beaker digestion. Other trace elements and base metals were analyzed by inductively coupled plasma atomic emission spectroscopy (ICP–AES). All samples were analyzed for precious metals by ICP–AES.

MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS

Disraeli Intrusion

Subdivision of the Disraeli intrusion in to peridotite and olivine gabbro phases is evident in the lithogeochemistry. The peridotites have higher MgO contents and plot along a trend indicating that fractionation was controlled by olivine and clinopyroxene, in contrast to the olivine gabbro that follows a trend controlled mainly by fractionation of plagioclase and clinopyroxene (Figure 9). Similar mineralogical controls were suggested by Sutcliffe (1987). The total rare earth element (REE) and high field strength element (HFSE) concentrations in the peridotite are generally lower than the olivine gabbro, with the exception of scandium, which is probably related to the higher clinopyroxene content of the peridotite (Figure 10). However, the 2 units have comparable REE ratios which are distinctly higher than the diabase sills, but which are similar to the Lower Suite of volcanic rocks of the Osler Group as was noted by Sutcliffe (1987) (Figure 11). The peridotites and olivine gabbros are not enriched in nickel, and the peridotites follow an olivine-controlled igneous fractionation trend, which would be consistent with a parental MgO concentration of 13 weight % (Figure 12). The presence of pink feldspar in the olivine gabbro appears to correlate with an enrichment in K_2O, possibly a later magmatic fractionation or may be related to assimilation of Sibley Group sediments shown a cross in Figure 13. The peridotite and olivine gabbro have REE and HFSE ratios that are comparable to ocean island basalts in contrast to the diabase sills (*see* Figure 10).

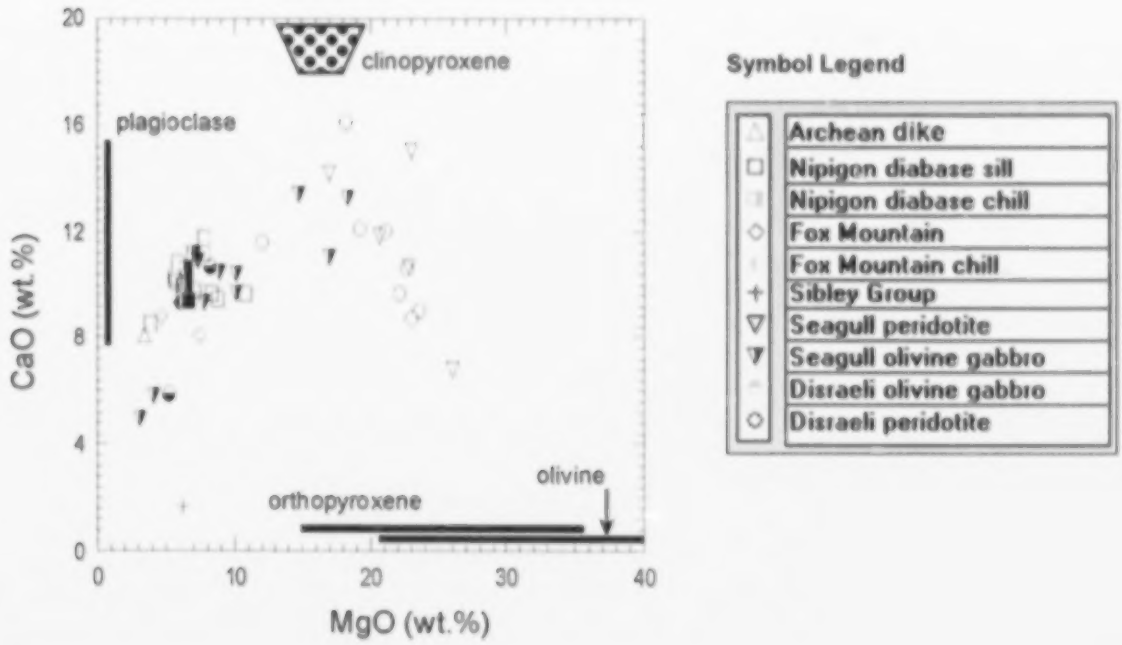

Figure 9. MgO versus CaO diagram of the mafic to ultramafic intrusive rocks and the Nipigon diabase sill complex (*after* Sutcliffe 1987).

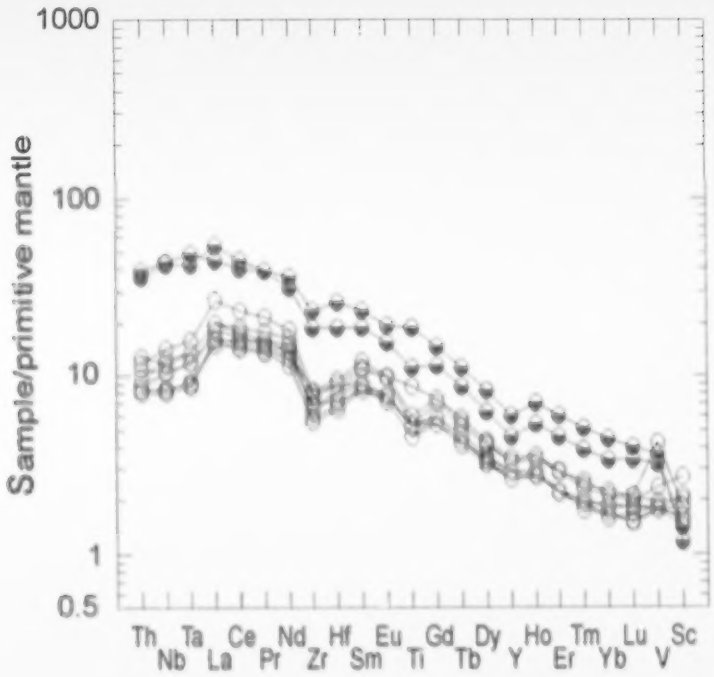

Figure 10. Mantle-normalized extended element diagram of the mafic to ultramafic intrusive rocks of the Disraeli intrusion (normalizing factors *from* Sun and McDonough 1989). Legend for symbols, *see* Figure 9.

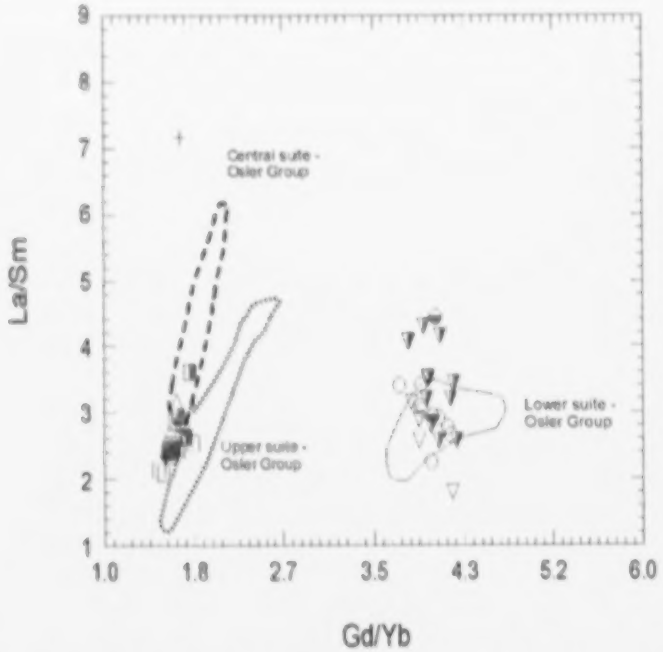

Figure 11. Gd/Yb versus La/Sm diagram of the mafic to ultramafic intrusive rocks and the Nipigon diabase sill complex with fields for the volcanic rocks of the Osler Group (*after* Lightfoot et al. 1991). Legend for symbols, *see* Figure 9.

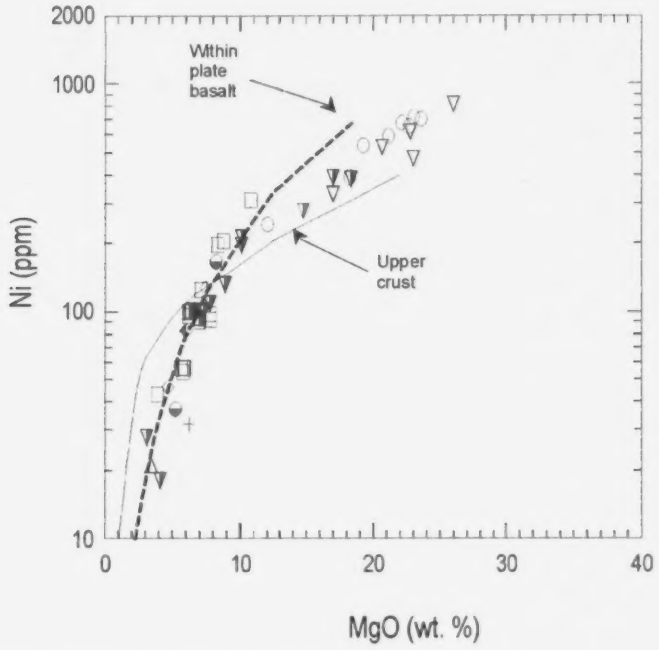

Figure 12. MgO versus nickel diagram of the mafic to ultramafic intrusive rocks and the Nipigon diabase sill complex (*after* Lightfoot et al. 1991). Legend for symbols, *see* Figure 9.

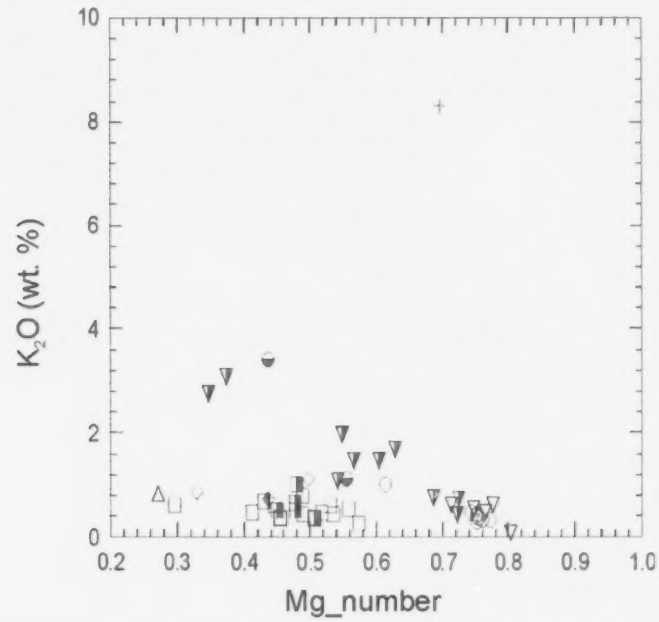

Figure 13. Mg number versus K_2O diagram of the mafic to ultramafic intrusive rocks and the Nipigon diabase sill complex. Legend for symbols, *see* Figure 9.

Seagull Intrusion

The Seagull intrusion is being studied in detail by Heggie and Hollings (2004) and the following discussion is based on their findings. The peridotite exhibits a decrease in total REE and HFSE abundances, accompanied by an increasingly negative europium (Eu) anomaly, upward through the intrusion. Preliminary investigations have identified 3 units based on differences in their trace element abundance. A basal unit is in contact with the Quetico Subprovince metasedimentary and felsic intrusive rocks, and is characterized by LREE enrichment and HREE depletion with $[La/Sm]_n$ ratios 1.4 to 3.0 and $[Gd/Yb]_n$ ratios of 3.1 to 4.0. A main unit is characterized by $[La/Sm]_n$ ratios of 0.9 to 1.9, a negative Eu anomaly, and increasing fractionation between lutetium (Lu) and vanadium (V). A sub-main unit has REE values between the basal and main units and fractionated HFSE.

Geochemical data for the olivine gabbro of the Seagull intrusion also plots along a trend indicating that fractionation was controlled mainly by plagioclase and clinopyroxene (*see* Figure 9). The REE and HFSE concentrations are generally higher than the peridotite (Figure 14) and the 2 units have comparable REE ratios, similar to the Lower Suite of volcanic rocks of the Osler Group (*see* Figure 11). As in the Disraeli intrusion, the peridotites and olivine gabbros are not enriched in nickel (*see* Figure 12). Overall, the Seagull intrusion has REE and HFSE concentrations characteristic of ocean island basalts as proposed by Heggie and Hollings (2004) (Figure 15).

NIPIGON DIABASE SILL COMPLEX

Mapping and geochemical sampling by Sutcliffe (1986) and Hart, terMeer and Jolette (2002) indicate that the sills probably do not represent a single cooling phase, and were formed by multiple pulses of magma. However, the variations are subtle and generally not distinctive enough to be evident in a group of outcrop samples. The diabase sills plot along a line indicative of fractionation controlled mainly by plagioclase and clinopyroxene as suggested by Sutcliffe (1987) (*see* Figure 9). Although the CaO and MgO contents of the diabase are distinctively different from the peridotites, a trend subparallel to the olivine gabbro accounts for some of the similarities in appearance in the field. The diabase display a range in REE and HFSE concentrations that will require further investigation (Figure 16), but the ratios are distinct from those of the peridotites (*see* Figure 11). Some HFSE and REE ratios for the diabase show some similarities to the Central and Upper Suite volcanic rocks of the Osler Group as has been suggested by Sutcliffe (1987) (Figures 11 and 17). The Nipigon diabase sills have lower TiO_2, Zr/Y, La/Yb values than the Logan diabase sills located to the south of Thunder Bay (*see* Figure 17) and have a regional distribution that extends south to at least the north side of the City of Thunder Bay (Hart 2003). Several samples collected from the area south of Thunder Bay have geochemical characteristics comparable to the Nipigon diabase sills (*see* Figure 17), but further investigation is required. This regional geographic distribution of high and low TiO_2 rocks is similar to regional distributions observed in some flood basalt provinces (e.g., Mantovani et al. 1985). The Nipigon sills are not enriched in nickel (*see* Figure 12), and samples from the Beardmore area suggest that the sills have not been depleted in PGE (Hart, terMeer and Jolette 2002). The diabase sills have HFSE and REE ratios with some similarities to subduction zone basalts and the Central and Upper Suites of the Osler Group (*see* Figure 15).

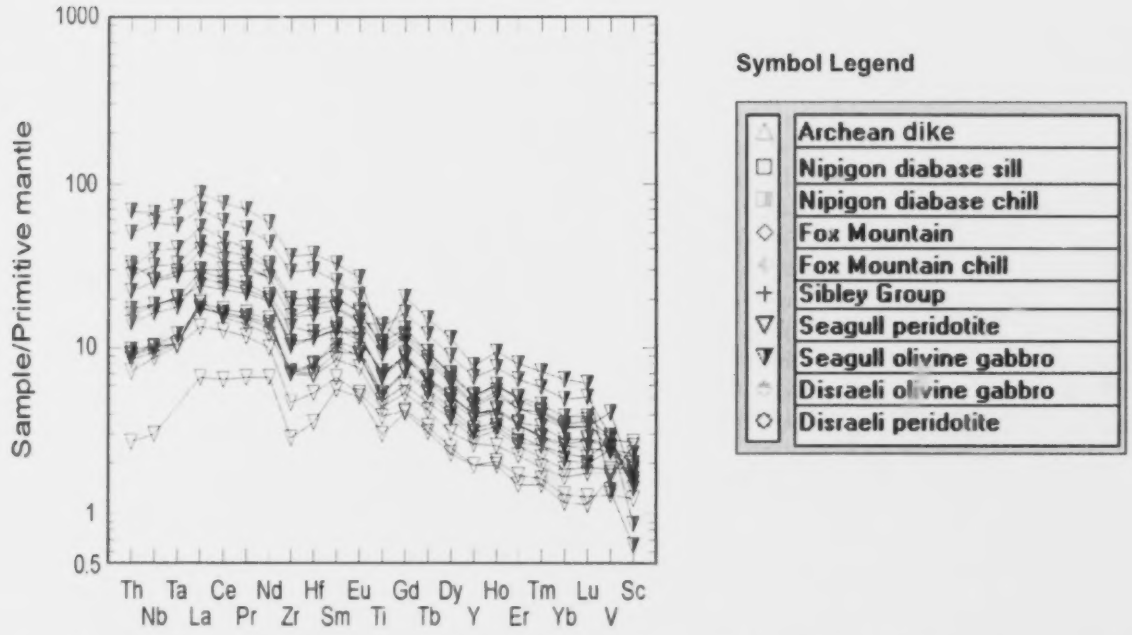

Figure 14. Mantle-normalized extended element diagram of the mafic to ultramafic intrusive rocks of the Seagull intrusion (normalizing factors *from* Sun and McDonough 1989).

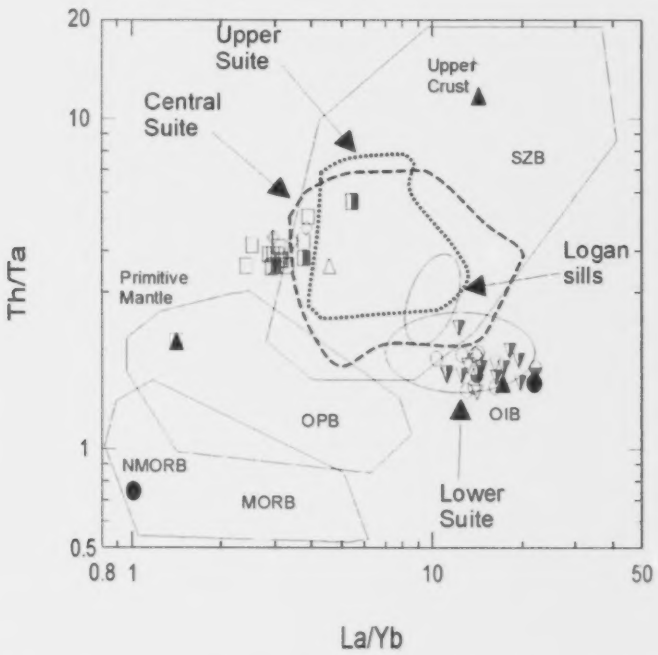

Figure 15. La/Yb versus Th/Ta diagram of the mafic to ultramafic intrusive rocks and the Nipigon diabase sill complex with fields for the volcanic rocks of the Osler Group and the Logan diabase sills south of Thunder Bay (*after* Condie et al. 2002). Legend for symbols, *see* Figure 14.

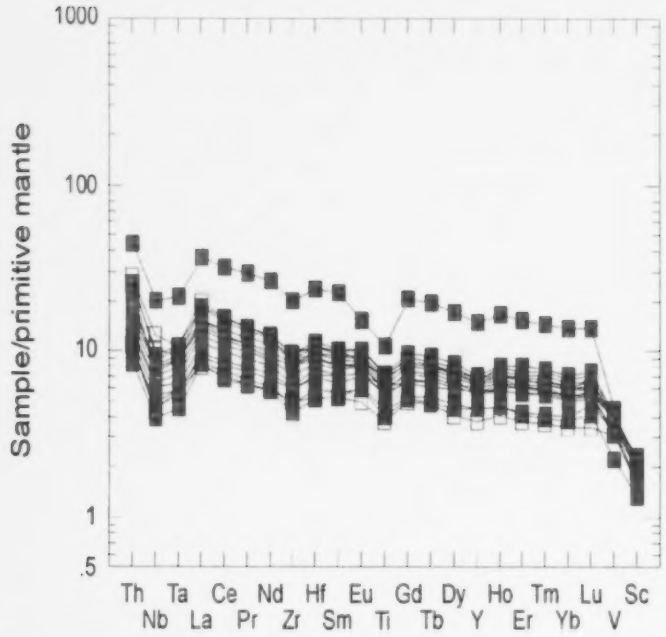

Figure 16. Mantle-normalized extended element diagram of the Nipigon diabase sill complex (normalizing factors *from* Sun and McDonough 1989). Legend for symbols, *see* Figure 14.

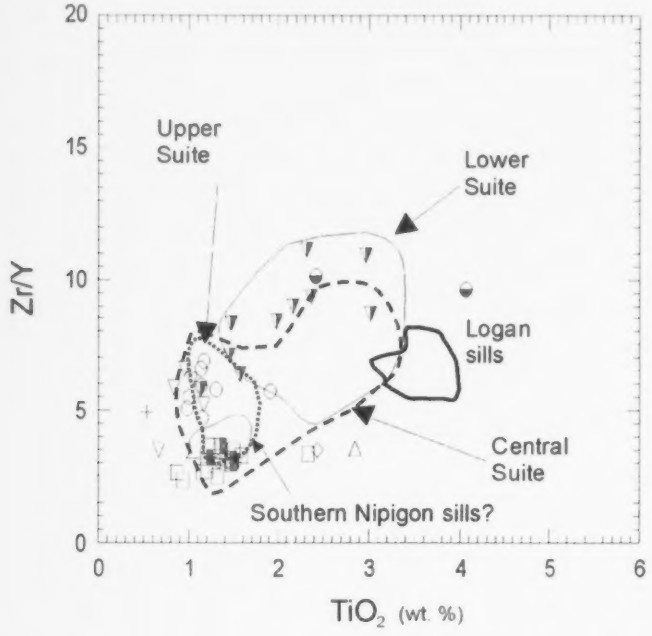

Figure 17. TiO_2 versus Zr/Y diagram of the mafic to ultramafic intrusive rocks and the Nipigon diabase sill complex with fields for the volcanic rocks of the Osler Group and the Logan diabase sill south of Thunder Bay. Legend for symbols, *see* Figure 14.

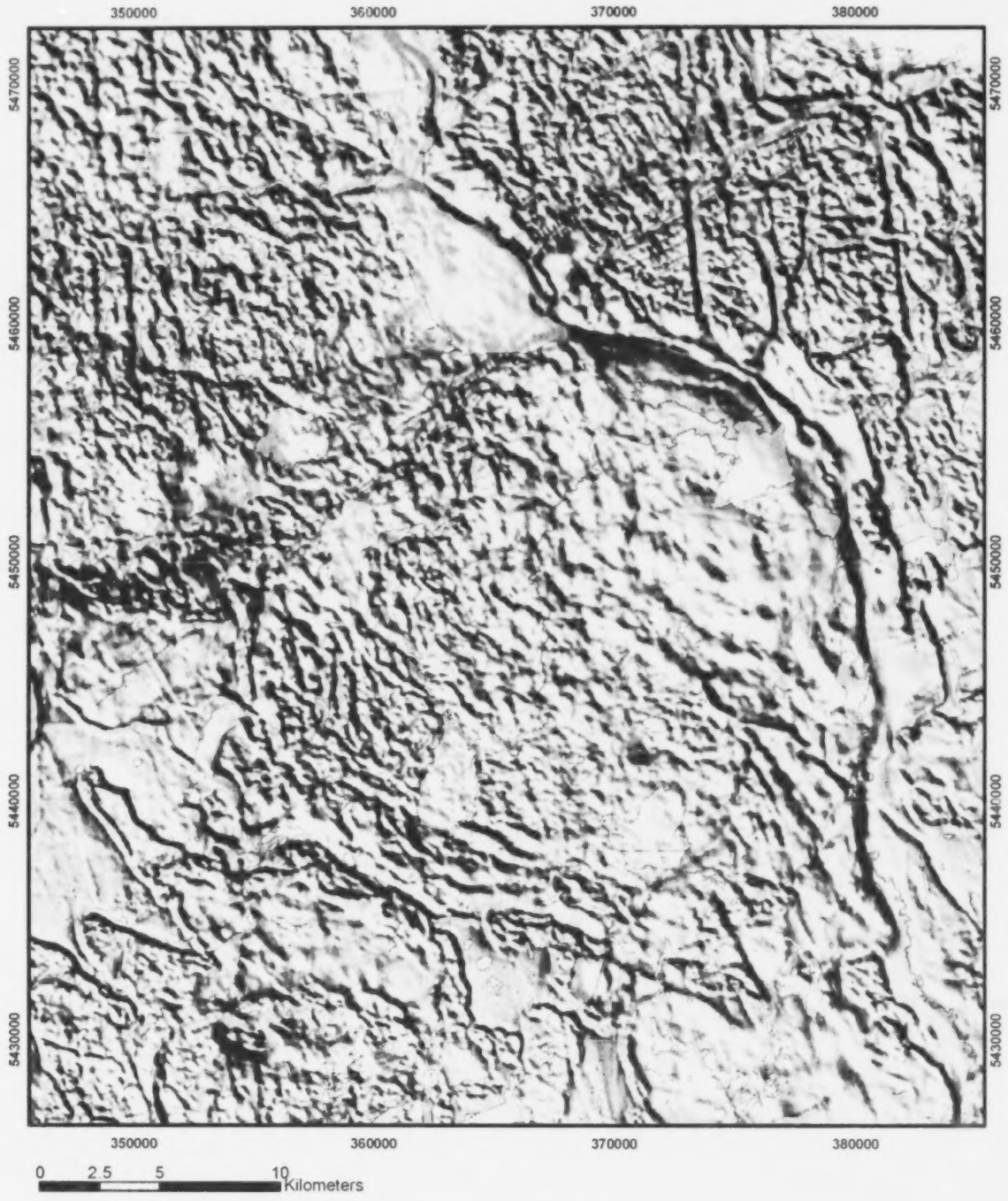

Figure 18. First vertical derivative of the airborne total magnetic field in the northern Black Sturgeon River map area.

Geophysical Surveys

A airborne magnetometer and gamma-ray spectrometer survey of 49 693 total line-kilometres was flown over an area along the west side of Lake Nipigon extending from Dorion to just south of Armstrong, during the summer of 2003 (Ontario Geological Survey 2004). This survey was flown 100 m above ground level, using a 150 m flight line separation and covered the entire map area. A program of ground gravity surveying to supplement the existing gravity stations was also commenced and the expected release of the results of the gravity survey will be in the summer of 2004. Magnetic susceptibility measurements were recorded for each rock type at nearly every station during the mapping project, and specific gravity measurements were for all sample analyzed for whole rock geochemistry (MRD 133).

The results of the aeromagnetic and gamma-ray spectrometer survey have been used to assist in the interpretation of the geology, particularly in areas with little outcrop. The total field magnetic and calculated first vertical differential magnetic products are useful in delineating the magnetite bearing diabase sills and the Archean iron formations (Figure 18; *see also* Figure 3). The sill edges produce strong anomalies that were probably controlled by regional faulting. The gamma-ray spectrometer survey potassium and thorium responses were useful in delineating the Archean felsic intrusion rocks exposed to the east of the Black Sturgeon River, as well as the Kama Formation of the Sibley Group in the southern portion of the map area (*see* Figures 3, 4 and 18).

Structural Geology

The metavolcanic and metasedimentary rocks of the Archean Wabigoon and Quetico subprovinces have a schistosity oriented at approximately 050°, which is usually along the bedding plane of the metasedimentary rocks. In a few locations with more competent lithologies, such as quartz veins or leucocratic tonalite dikelets, there appears to have been isoclinal folding of some beds. The more competent lithologies also provide evidence of extension along the schistosity, possibly related to the folding event (*see* Photo 1). The mafic metavolcanic rocks occur as relatively thin horizons interbedded with the metasedimentary rocks suggesting that they were more competent and have been attenuated during deformation. North-trending fracturing is common and, in a few locations, there is evidence of a 1 to 2 cm sinistral displacement. The felsic intrusive dikes and dikelets intruding the metavolcanic and metasedimentary rocks generally follow the trend of the schistosity. The larger muscovite granite bodies appear to have more irregular contact orientations, but may be controlled by the regional fabric on a larger scale.

The Wabigoon–Quetico subprovincial boundary is indistinct and is tentatively located toward the southern end of Black Sturgeon Lake, as had been proposed by Sutcliffe (1982). The position of the boundary is not defined by a major structure, but rather is based on the correlation of regionally continuous iron formations. Interpretation based on the airborne geophysical magnetometer surveys suggests that the iron formations correlate with similar units in the metasedimentary sub-belts of the Beardmore–Geraldton greenstone belt (Gupta 1991). This same series of iron formations can be traced by the airborne geophysics to the west, to the Mawn Lake area (Coates 1972) and the north side of the Max Lake greenstone belt.

The Sibley Group sedimentary rocks are relatively flat lying, dipping 5 to 15° east and striking approximately northwest. However, as a result of sedimentation processes that probably produced an irregular depositional surface on the scale of an outcrop, the orientation of the bedding orientation is variable (P. Fralick and B. Rogala, Lakehead University, personal communication, 2003). The Sibley Group thickens to the south where 2 additional formations overlie the Kama Hill formation (Rogala

2003), and thins to the north and west (e.g., Cheadle 1986). The sedimentary rocks unconformably overlie the Archean metavolcanic and metasedimentary rocks, and Cheadle (1986) estimated up to 200 m of topographic relief on the Archean paleosurface at the time of deposition of the Sibley Group. These surface irregularities, combined with overlying diabase sills, are interpreted to be part of the control on the distribution of the Sibley Group in the area east of the Black Sturgeon River.

The diabase sills are generally flat lying to gently undulating and the few observed sill contacts generally dip less than 10° to the south. However, due to the undulating nature of the contacts, this orientation may only have local significance. Sill contacts locally dip up to 30° in either an east or west direction along north-trending ridges. The best examples of sill contacts have chill contacts with the one east of Ferguson Lake containing xenoliths of Quetico Subprovince metasedimentary rocks, and the one southwest of McIntyre Bay was chilled against Sibley Group sedimentary rocks. One interpretation of the Fox Mountain ridge would be a similar sloping contact, but on a much larger scale. A change in sill orientation or short distances is common in other mafic sill complexes (e.g., Tasmania: Leaman 1975; Karoo: Chevallier and Woodford 1999). This change in orientation may be due to a number of factors including a change in orientation of the principal stress direction (Gretener 1969) and following pre-

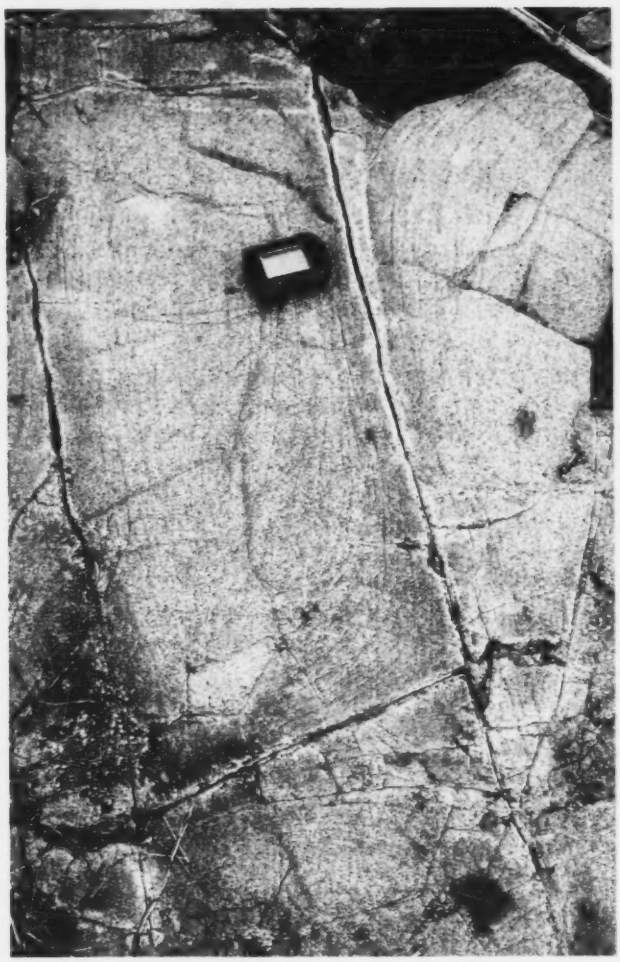

Photo 20. Polygonal jointing with concentric cooling fractures (station 1059). Hewlett–Packard IPAQ™ 3950 is approximately 15 cm long.

existing structures. There appear to be at least 2 major sills and possibly a number of thinner (5 to 25 m) sills in the area, but correlation between outcrops and diamond-drill holes is complicated by the interpreted presence of block faulting (*see* "Cross Section").

Jointing in the diabase sills may be either arcuate or linear. The arcuate joints vary in strike direction by up to 70° and are commonly observed on horizontal surfaces. These joints are interpreted to be cooling fractures and may form networks of crudely polygonal joint sets, and probably represent the large-scale jointing, which is commonly observed in the cliff exposures of the major sills. In a few locations along the Church Lake Road, southwest of Graydon Lake, the polygonal joints display roughly concentric cooling fractures (Photo 20). The crude polygon joint pattern with "T" or flattened "Y" junctions are commonly observed only near the base of columnar jointed flows, but may correlation with a longer polygonal joint face length as observed in some locations (e.g., Aydin and DeGraff 1988). Linear joints are commonly north trending and transect the cooling fractures suggesting that they are associated with late, possibly regional, structures. The current distribution and outline of the sills appears to have been controlled by these regional structures or faults.

FAULTS

There are 2 major regional fault trends that have displaced rock units in the map area and form the Black Sturgeon River fault zone, and a third trend that may only represent minor late movement along pre-existing Archean structures (Figure 19). A series of north-trending faults are the dominant structures in the map area. A series of subparallel, northwest-trending faults form part of the fault zone, and may be traced to the west into the adjacent Wabigoon Subprovince. A number of northeast-trending faults parallel the fabric of the Wabigoon and Quetico subprovinces. Accurate determination of displacements on these structures is not possible as they have been obscured by talus slopes and glacial deposits.

The north-trending faults have been interpreted to be *en échelon* resulting in the formation of an asymmetric basin or graben as originally proposed by Coates (1972). Vertical displacements are discussed below (*see* "Cross Section"), and there appears to have been little lateral displacement based on the correlation of the iron formations across Black Sturgeon Lake. These faults are interpreted to be regionally continuous structures that can be traced for over 50 km and the apparent northwest deviation is thought to be a result of separate northwest-trending structures. This interpretation means that the fault that forms the major escarpment along the east side of the Black Sturgeon River continues to the north through the area of Ferguson Lake. The escarpment along the river between Black Sturgeon and Nonwatin lakes is controlled by a northwest-trending fault. Thus, the north-trending faults that cut and may have controlled the emplacement of the Seagull and Disraeli peridotite intrusions, and possibly the Fox Mountain diabase, can be traced at least as far north as Circle Lake. These faults may also correlate with north-trending structures in the northern Gull Bay area of the northern map area (MacDonald et al. 2004) as has been previously proposed by a number of authors (e.g., Middleton 2001).

The northwest-trending faults are evident in the topography and exposure of diabase of this map area. These faults appear to form part of the Black Sturgeon fault zone that resulted in the major uplift of the area to the east of the Black Sturgeon River, and controlled the deposition of the Sibley Group sedimentary rocks. These faults are prominent in the southwest portion of the map area, and may also have had some control on the emplacement of the peridotite intrusions.

The northeast-trending faults are less well defined and appear to parallel the fabric of the Wabigoon and Quetico subprovince rocks. These faults appear to have some control over the distribution of the diabase sills, but it is not clear whether there has been any major displacement along the structures. It is difficult tracing these faults into the central and western portions of the map area.

The timing of the different faults is not known, and it is probable that there has been re-activation of the structures. There have been several proposals to account for the structural history of the area, with most revolving around the Sibley Group sedimentary rocks. Coates (1972) proposed a half graben with the Black Sturgeon River as the eastern boundary as the main control on the deposition of the Sibley Group sedimentary rocks. Franklin et al. (1980) proposed that a failed arm of the Mesoproterozoic Keweenawan Midcontinent Rift created a basin, which included the half graben. Sutcliffe (1986) further developed the failed arm model as a major control on the emplacement of the peridotite intrusions and the diabase sills.

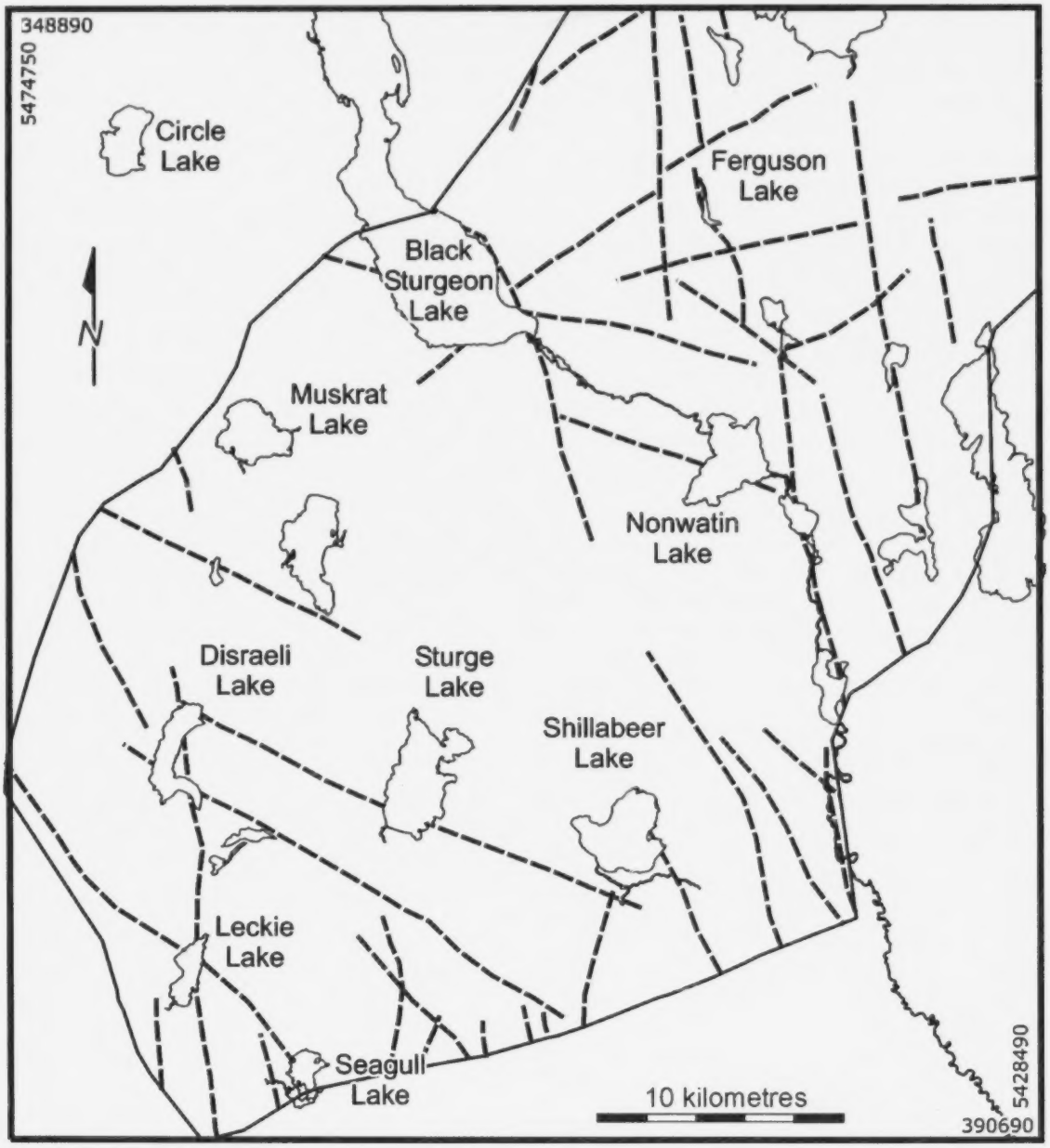

Figure 19. Distribution of major faults and regional structures in the northern Black Sturgeon River and Disraeli Lake map area.

Alternatively, Fralick and Kissin (1995) proposed that thermal upwelling that formed the English Bay complex was followed by relaxation and formation of an intracratonic basin in which the Sibley Group was deposited.

The presence of Pass Lake Formation rocks at the base of a number of diamond-drill holes in the map area, and the lack of significant Pass Lake Formation to the east, suggests that the half graben was present before the deposition of the Sibley Group at 1339±33 Ma (Franklin 1978). However, the Sibley Group extends as far north as Armstrong and as far east as the Beardmore area, indicating that a large regional basin was present at the time of sedimentation. The proposed correlation of the of the north-trending fault in the Seagull and Disraeli lakes area with those in the Gull Bay area suggests that emplacement of the English Bay complex at 1536+10/–2.3 Ma (Davis and Sutcliffe 1985) may have been controlled by a similar structure. The age of the English Bay complex would suggest that initial activity on the north-trending faults was earlier than the formation of the half graben. Extensive hematite and the occurrence of uranium mineralization in north-trending structures (1090±20 Ma: Ruzicka and LeCheminant 1984) suggests that there was activity along these faults after deposition of the Sibley Group. However, this age may overlap with the emplacement of the Nipigon sills at 1109+4/–2 Ma (Davis and Sutcliffe 1985). Therefore, due to the lack of a distinctive marker within the diabase sills, it is not clear whether the fault activity after sill emplacement resulted in significant offset.

CROSS-SECTIONS

Two cross-sections extending from 1) the Seagull intrusion in the southwest to Magee Lake in the east and 2) the Seagull intrusion in the south to Muskrat Lake in the north (Figure 20: A–A′ and B–B′, respectively) were constructed based on outcrop, diamond drill hole, and airborne geophysical information (*see* Map P.3540). Interpretations of the displacement on the north- and northwest-trending faults are based on the proposed correlation of the Sibley Group sedimentary rocks along these sections. However, information is limited as diamond-drill holes could be separated anywhere by up to 15 km and the sills have removed portions of the Sibley Group hindering stratigraphic correlations. A number of assumptions were made in the construction of these sections, and include 1) the sills and Sibley Group sedimentary rocks are flat lying, although both lithologies probably dip at 5 to 15°; 2) faults have been oriented vertically, as there is not enough information available on the possible dips; 3) the depth to the Quetico Subprovince basement rocks decreases to the west and south, although it is not known whether this decrease is gradual or abrupt.

The west to east section (*see* Figure 20: A–A′) suggests that there is an approximately 350 m fault scarp along the fault paralleling the Black Sturgeon River. This displacement is similar to estimates of 213 to 305 m by Coates (1972) and 420 m by Sutcliffe (1986). Stratigraphic correlation of the Sibley Group across this fault suggests that most of the fault movement predated the deposition of the sedimentary rocks. Offset postdating the Sibley Group appears to be on the order of less than 100 m. A north-trending fault east of Magee Lake appears to have uplifted the Sibley Group on the east side of this section. West of the Black Sturgeon River, a series of north-trending and northwest-trending faults are interpreted to successively uplift the block to the west by less than 50 m. The result of the faulting is that between the Black Sturgeon River and the west side of the Seagull Intrusion, the Quetico Subprovince basement rocks have been uplifted from about 100 m below sea level to about 340 m above sea level. The presence of the block faults is interpretative and, alternatively, a model of a shallowly east dipping sequence with no faulting is equally possible. There is evidence that there may be 3 major sills in the area, although this interpretation is dependant on the displacement on the fault west of diamond-drill hole ST02-01. A feeder zone, or zones, for the sills has not been represented on the section as there is no evidence as to their location, whether there is one or multiple feeders, or which fault would be the most likely magma conduit. The sill at the base of the hill, east of the river, is the same sill that is outlined

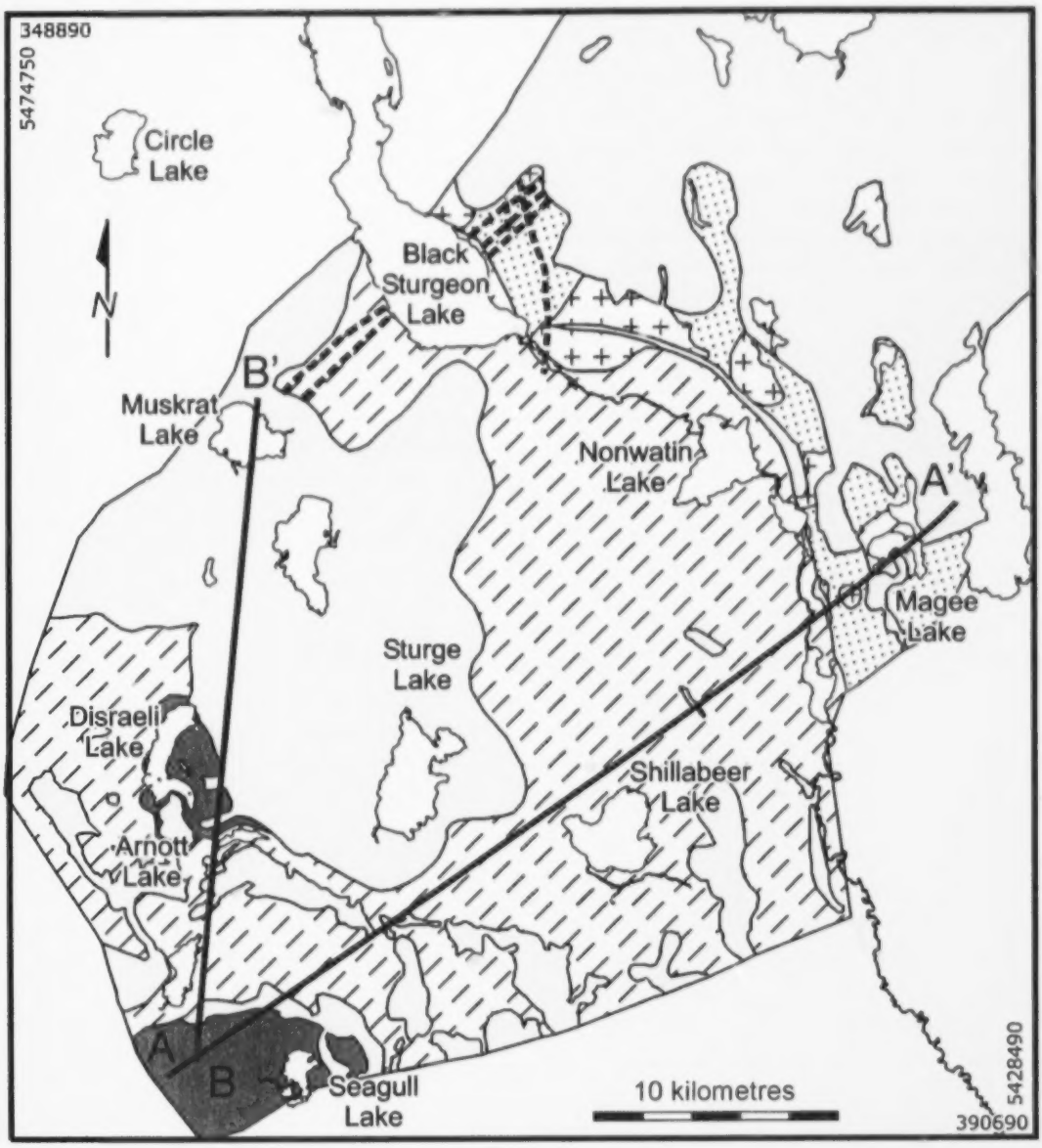

Figure 20. Location of geological cross-sections A–A' and B–B' shown on Preliminary Map P.3540 (*see* back pocket).

northwest of Nonwatin Lake, and has been interpreted to underlie the sills exposed along the Church Road. The sill outcrop west of the river is intersected in diamond-drill hole DDH-3 and is interpreted to be part of the sill that crops out around Sturge Lake north of this section. Movement along these faults appears to have occurred after the deposition of the Sibley Group, and there is no evidence of displacement after intrusion of the diabase sills.

The south to north section (*see* Figure 20: B–B′) is interpreted to indicate a successive uplift of the blocks along several northwest-trending faults such that the Quetico Subprovince basement rocks have been uplifted from approximately 200 m below sea level to about 260 m above sea level along the length of the section. As on the west to east section, there is little control on some part of the section and the same data may be interpreted to represent a shallow dip. It is also possible that the elevation of the Quetico Subprovince basement rocks is being controlled by original topographic variation as proposed by Cheadle (1986). Only 2 major sills are apparent in this section, although a sill–sill contact is interpreted at the base of the Fox Mountain ridge in the centre of the section. This contact is based on the chill contacts observed in outcrop. The sill in the upper portions of the Muskrat Lake diamond drill holes, ML01-01 and ML01-02, is interpreted to be the same sill cropping out in the area of Sturge Lake and intersected in the upper portion of the Bitterroot diamond-drill holes DDH-3 and DDH-5. The high angle of the contacts on the peridotites is partly due to the vertical exaggeration. but may also be reality. A feeder zone was not shown for the peridotites, or the diabase sills, as there is currently no evidence to their location.

Economic Geology

PLATINUM GROUP ELEMENTS

Seagull Intrusion

Mineralization in the Seagull intrusion is hosted by the peridotite and is exposed in partially filled-in trenches located on the logging road between Seagull and Leckie lakes (Figure 21). Sampling of these trenches by Avalon Ventures Limited returned assays up to 2610 ppb Pt and 1145 ppb Pd in the Central zone (Osmani and Rees 1998). Work on the property has included prospecting, geological mapping, and magnetic and electromagnetic geophysical surveys (e.g., Schnieders et al. 2003). Eighteen diamond-drill holes, totalling approximately 8328 m, have been completed in the Seagull intrusion to investigate the platinum group element (PGE) mineralization, with details of the diamond drilling provided in MRD 133. The most significant mineralization was intersected at or near the basal contact of the peridotite with metasedimentary rocks of the Quetico Subprovince. The best intersection returned 1.71 ppm Pt and 1.87 ppm Pd over 2.1 m in a biotite pyroxenite containing 10% disseminated to net-textured sulphide minerals including pyrite, pyrrhotite and minor chalcopyrite (Durham 2000).

The mineralization has been characterized by Heggie and Hollings (2004) and the following details are from that source. Mineralization is present in 3 units—basal, sub-main and main—but it is most significant in the basal and sub-main units. Mineralization in the basal unit is present near the lower contact of the intrusion, and is interpreted to be caused by sulphur saturation of the magma during initial stages of emplacement. Within the sub-main unit, mineralization is associated with more primitive whole rock geochemistry and mineralogy possibly reflecting an influx of less evolved magma. Nickel and copper sulphide minerals occur as disseminated bravoite and chalcopyrite, respectively, found interstitial to olivine. Copper is also present as veinlets of native copper crosscutting sulphide minerals. Platinum group minerals are located at the grain boundaries of NiFe sulphide minerals, and are dominated by sperrylite, keithconnite, stibiopalladinite and a copper palladium alloy.

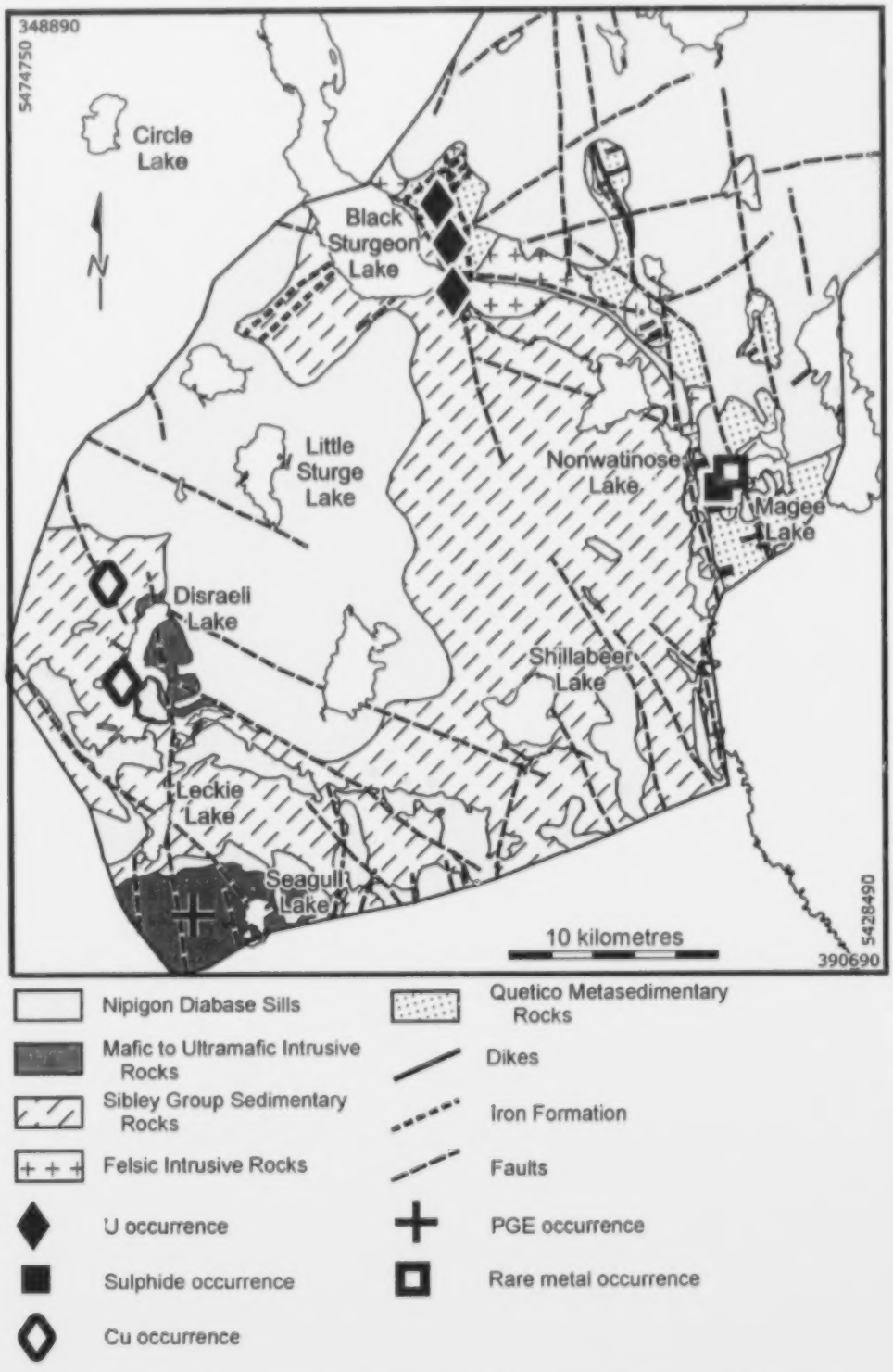

Figure 21. Mineral occurrences in the northern Black Sturgeon River and Disraeli Lake map area.

Disraeli Intrusion

Although lithologically and geochemically similar to the Seagull intrusion, mineralization has not been identified in the Disraeli intrusion. Five diamond-drill holes, totalling approximately 1917 m, have been completed within and south of the intrusion by Avalon Ventures Limited in 2000; additional details for these diamond-drill holes are contained in MRD 133 (*see* folder "drill_logs"; file "DDH"). Significant sulphide mineralization was not observed during the current mapping program.

Other Properties

A number of other areas have been explored in the map area for Cu±Ni±PGE mineralization and there has been no indication of any more than anomalous results (e.g., Schnieders et al. 2003). The work completed is summarized in Table 2, and additional information regarding the diamond drill holes is contained in MRD 133.

Table 2. Past exploration work for copper, nickel and/or PGE mineralization.

Company	Year	Past Work	Diamond Drill Holes	Map Number [1]
McVicar Minerals Limited	2001	Electromagnetic, magnetic, gravity surveys	ML01-01, ML01-02, ML01-03	4
Teck Cominco Ltd.–East West Resource Corporation	2002	Airborne magnetic and electromagnetic surveys, horizontal loop electromagnetic survey	SR02-01	5
Bitterroot Resources Limited	2001	Ground magnetic survey and gravity survey	DDH-1, DDH-2, DDH-3, DDH-4, DDH-5, DDH-6	8
Teck Cominco Ltd.–East West Resource Corporation	2002	Airborne magnetic and electromagnetic surveys, horizontal loop electromagnetic survey	ST02-01	9

[1] Map number refers to property numbers on Preliminary Maps P.3538 and P.3539.

COPPER

A number of companies have explored in the area of Disraeli Lake since the discovery of copper mineralization in 1965. Mineralization consists of chalcocite hosted by the diabase sill or underlying Sibley Group sedimentary rocks (Coates 1972) with occurrences shown in Figure 21. The exploration results are presented by Coates (1972), and summarized in Table 3 with additional information regarding the diamond-drill holes contained in MRD 133 (*see* folder "drill_logs").

Table 3. Past exploration work for copper mineralization.

Company	Year	Significant Results	Diamond Drill Holes	Map Number [1]
Algoma Steel Corp. Ltd.	1967	trace chalcopyrite in diabase	DL-1-67, DL-2-67, DL-3-67	6
Commerce Nickel Mines Ltd.	1965	Minor galena, native copper	drilled, but not in assessment files	7
Phelps Dodge Corp. of Canada Ltd.	1968	5 holes - not in assessment files		10
W. McAteer–W.P. Gilbert	1967	3 holes – not in assessment files		12
Noranda Exploration	1992	not filed for assessment	NI92-7, plus one unidentified	13
W. Ranta		no record in assessment files	R-1, R-2, R-3, R-4	14

[1] Map number refers to property numbers on Preliminary Map P.3539.

RARE METAL

Pegmatitic, muscovite leucogranite dikes, ranging from 2 to 10 m wide, intrude the Quetico Subprovince metasedimentary rocks southeast of Nonwatinose Lake (*see* Figure 21). The dikes vary in composition along their length and are composed of predominantly quartz, potassium feldspar and plagioclase that are usually graphically intergrown. A number of dikes, particularly those intruding the hornblende granite present in the same area, contain graphic intergrowths of black tourmaline and quartz. Fine-grained, subhedral, reddish brown garnet is present in some dikes, and plumose muscovite-quartz intergrowths is hosted in one dike along the logging road. These textures are commonly observed in rocks that have been classified as fertile granites, or granites that have the potential to host rare-element mineralization (Breaks, Selway and Tindle 2003). Samples of the dike containing the plumose muscovite-quartz intergrowths are currently being examined for more accurate classification.

SULPHIDE MINERALIZATION

Sulphide mineralization is hosted by the Quetico Subprovince andalusite schist located southeast of Nonwatinose Lake, east of the Black Sturgeon River (*see* Figure 21; UTM Zone 16, NAD83, 382678E, 5451908N). Mineralization consists of up to 20% disseminated pyrite and pyrrhotite in a 30 cm wide silicified zone extending for approximately 1.5 m along the foliation of the metasedimentary rocks. This mineralization occurs in an area intruded by several pegmatitic leucogranite dikes. Two samples were collected and the best assays returned are 345 ppm Cu, 63 ppm Zn and 73 ppb Au (*see* MRD 133, "assay", sample 03TRH309, station 72).

A metamorphosed metasedimentary rock composed of predominately garnet and anthophyllite is reported to contain up to 3% pyrrhotite (J.F. Scott, Resource Geologist, Resident Geologist's Office, Thunder Bay, personal communication, 2004). The unit is exposed in a small blast pit on the north side of the old road south of Black Sturgeon Lake uranium occurrence. The description of the unit resembles the amphibolitized iron formation exposed in the stripped zone of the uranium occurrence. No assay results have been reported.

URANIUM

There are 3 uranium occurrences in the north-central map area: the Black Sturgeon Lake, the Sturgeon Escarpment and the Split Rapid Dam occurrences (*see* Figure 21). The Black Sturgeon Lake uranium occurrence, discovered by Sutcliffe (1982), is still exposed in an area approximately 110 by 40 m stripped by Uranerz Exploration and Mining Corporation in 1983. The stripped area contains a northeast-trending sequence of feldspathic wackes and amphibolitized iron formation containing disseminated, trace to 1% pyrite, chalcopyrite and pyrrhotite in fractures. These units are intruded by a gabbroic-textured amphibolite, and a north-trending pegmatitic leucogranite dike. Series of north-trending fractures, that subparallel the trend of the Black Sturgeon fault zone, contain hematite, magnetite, calcite, pitchblende and uranopilite. Uranerz Exploration reported values up to 12% U_3O_8, and sampling by Scott (1987) returned values of 3.9% U, 6200 ppm Pb, and 323 ppm Cu from the main pit. A U/Pb age for the mineralization of 1090±20 Ma was reported by Ruzicka and LeCheminant (1984). The Sturgeon Escarpment occurrence is located on the hillside between the Black Sturgeon Lake and the Split Rapids Dam occurrences. This occurrence consists of massive to specular hematite hosted by fractured and brecciated metasedimentary and felsic intrusive rocks, with quartz and chalcedony (Scott 1987). Analysis of the hematite returned 800 ppm U, 100 ppm Ni, 0.01 ounce per ton gold and 0.10 ounce per ton silver (Scott 1987). The Split Rapids Dam uranium occurrence is located near the southeast corner of Black Sturgeon Lake. Mineralization occurs in a breccia within a reddish brown pegmatite dike (Scott 1987). Pitchblende is associated with epidote, amphibole, calcite and hematite.

Recommendations for Mineral Exploration

BASE METALS

Sulphide mineralization was identified in the area east of the Black Sturgeon River, hosted by metasedimentary rocks of the Quetico Subprovince (*see* Figure 21). The disseminated pyrite and pyrrhotite occur in pods along the foliation of the metasedimentary rocks and the best analytical results are 345 ppm Cu, 63 ppm Zn, and 73 ppb Au (*see* MRD 133, "assay", sample 03TRH309, station 72). The source of this mineralization is not understood, and it may represent either an early synsedimentary mineralization, or a later syntectonic mineralization. The extent and characteristics of this mineralization are not known, and prospecting along strike with this mineralization is recommended.

GOLD MINERALIZATION

The iron formations that underlie the northeast portion of the map area are the same iron formations that host the gold mineralization in the Leitch and Sand River gold mines in the Beardmore area (e.g., Hart, terMeer and Jolette 2002). These units also correlate with the iron formations that host gold mineralization in the Max Lake belt (e.g., Canamax Resources Inc., assessment file 52H03NW0005). In the Beardmore area, gold mineralization is structurally controlled in an area near a large-scale fold of a sedimentary–volcanic sub-belt boundary, with only minor associated sulphide mineralization. The results of the airborne magnetometer survey (Ontario Geological Survey 2004) suggest that there may be large-scale folding of the iron formation immediately north of the map area. Gold mineralization in the Max Lake area is associated with sulphide mineralization in the iron formation, and sulphide mineralization is associated with the iron formation located south of the Black Sturgeon Lake uranium occurrence (*see* Figures 21 and 3). These similarities suggest that there is a potential for gold mineralization associated with the iron formations within and immediately to the north of the map area.

PLATINUM GROUP ELEMENT MINERALIZATION

Platinum group element mineralization is hosted by the peridotite of the Seagull intrusion at 3 different levels (Heggie and Hollings 2004) (*see* Figure 21). The most significant mineralization was intersected at, or near, the basal contact of the peridotite with metasedimentary rocks of the Quetico Subprovince. Analysis of the best intersection returned 1.71 ppm Pt and 1.87 ppm Pd over 2.1 m in a biotite pyroxenite containing 10% disseminated to net-textured sulphide minerals including pyrite, pyrrhotite and minor chalcopyrite (Durham 2000). Heggie and Hollings (2004) propose that the basal PGE mineralization is the result of sulphur saturation of the magma during initial stages of emplacement, with mineralization at higher levels a result of an influx of less evolved magma. Work is ongoing, but these initial results suggest that any ultramafic intrusion has the potential to host PGE mineralization if the magma is PGE enriched at the time of emplacement. The recognition that the Disraeli and Seagull intrusions may be localized on a series of north-trending structures, which may extend as far north as the Gull Bay area, suggests a potential for additional ultramafic intrusions located along these structures. A similar parallel trend of north-trending structures through the Hele intrusion, located to the southeast of the map area, may form a similar favourable corridor along the Black Sturgeon River. The results of the geophysical surveys, particularly the ground gravity survey, should be useful in delineating areas with a greater potential to host another ultramafic intrusion.

URANIUM

Hematite alteration is common in both Archean and Proterozoic rocks and associated with north-trending structures (*see* Figure 21). The association of hematite and specular hematite with uranium mineralization in the Black Sturgeon Lake and Split Rapid Dam occurrences may be an indication of an association between the addition of iron and the uranium mineralizing event. However, the uranium is not associated with hematite in all locations suggesting that there are other factors that control the location of the uranium mineralization. These factors may include bedrock lithologies, the character of the structures, or the character of the mineralizing fluids. There may be slight differences in the timing of the hematite alteration in different parts of the map area that are not evident from field examinations. The mineralization age of 1090 Ma, reported by Ruzicka and LeCheminant (1984), suggests the existence of fluid circulation at approximately the same time as the intrusion of the diabase sills. However, further work is required to understand the timing and number of hematite alteration events and their metallogenic significance.

The Black Sturgeon Lake occurrence has many of the features of vein uranium mineralization, as described by Ruzicka (1996), which suggests that areas underlain by a faulted series of felsic intrusive rocks and clastic metasedimentary and metavolcanic rocks, that are variably hematized and chloritized and adjacent to carbonate or quartz-carbonate veins, are the most favourable targets for uranium exploration. Areas with these characteristics include areas underlain by Archean metavolcanic, metasedimentary and felsic intrusive rocks along the east side of the Black Sturgeon River that are cut by major regional faults and as blind mineralization targets beneath the Sibley Group to the west of the river (*see* Figure 21).

IRON OXIDE-COPPER-GOLD DEPOSITS

The iron oxide-copper-gold (IOCG) deposit type encompasses a broad range of mineralization styles including Carajas, Conclurry and Olympic Dam mineralization. These deposits are commonly associated with broad potassium and iron metasomatic alteration zones that are hosted by metavolcanic and metasedimentary rocks, intruded by granitoid rocks, and cut by deformation zones (e.g., Burrows 2003). The map area, particularly to the east of the Black Sturgeon River, contains several features that may be indicative of the IOCG style of mineralization. At this stage, the iron alteration is localized near faults and small-scale breccia zones, but regional potassium metasomatism has yet to be identified. The main exposed felsic intrusive rocks in the map area appear to be a S-type (sedimentary-derived) granite rather than the more common I type (igneous) associated with most other IOCG deposits. However, the presence of a major fault zone cutting a deformed interlayered sequence of metavolcanic and metasedimentary rocks is a favourable environment for such mineralization. Further work is required to evaluate the potential for this deposit type in the map area.

RARE METAL

The pegmatitic, muscovite leucogranite dikes east of the Black Sturgeon River contain intergrowths of tourmaline and quartz, and muscovite and quartz commonly observed in rocks that have been classified as fertile granites, or granites that have the potential to host rare-element mineralization (Breaks, Selway and Tindle 2003). Additional work is required to characterize these dikes. These dikes occur along the regional trend extending from Georgia–Barbaro lakes area in the northeast to the DeCourcey Lake and Onion Lake areas in the southwest (Breaks, Selway and Tindle 2003), and this area may represent a similar concentration of fertile granites. The abundance of dikes and the fact that these dikes have been examined in only a cursory manner during the mapping program means that additional prospecting is recommended in the area between Nonwatinose and Magee lakes (*see* Figure 21).

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Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 90**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

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